

No 16 Shaft Project



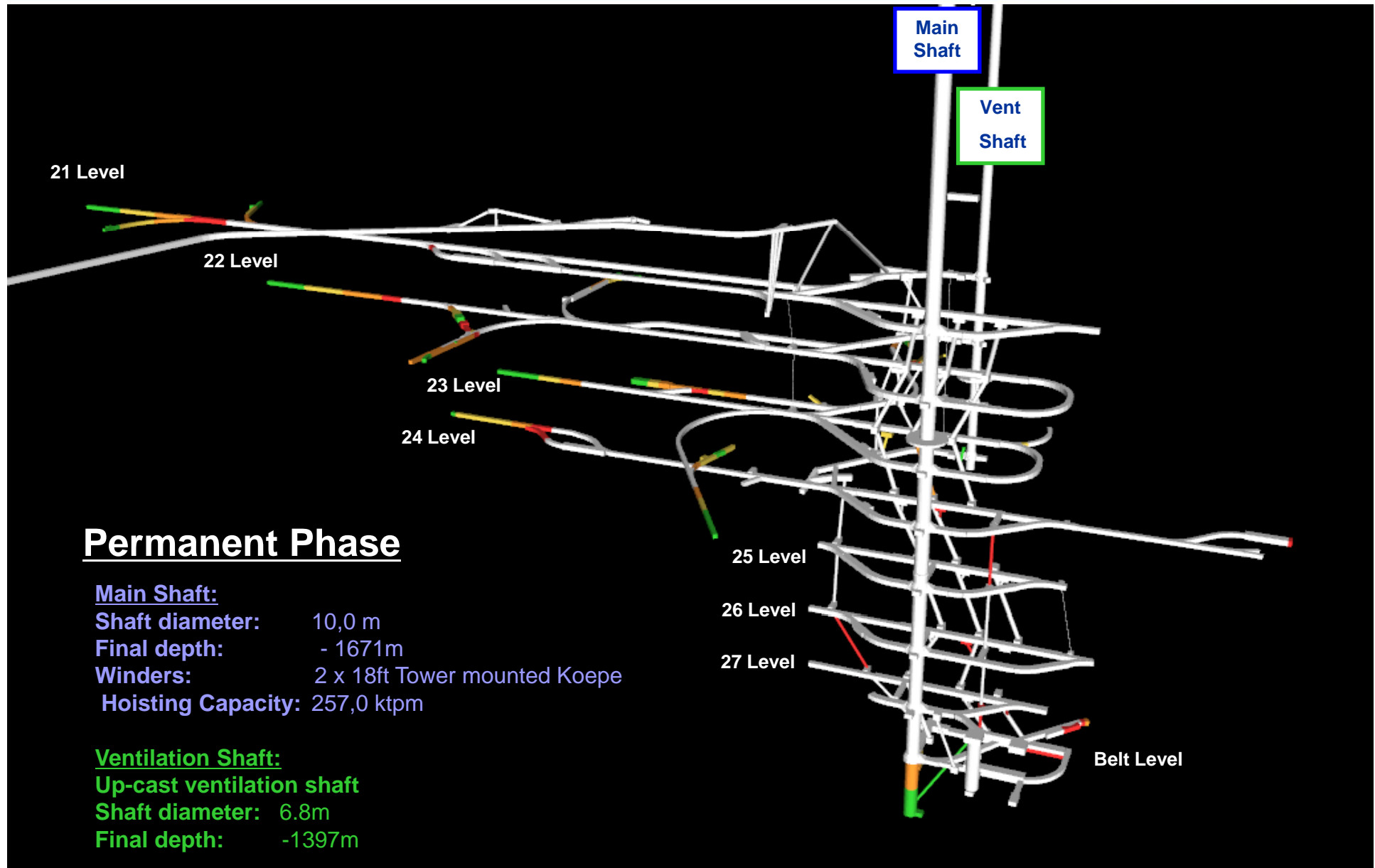
One Team One Vision With Pride

Stage Rope Incident
19 April 2011

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PROJECT OVERVIEW



Permanent Phase

Main Shaft:

Shaft diameter: 10,0 m
Final depth: - 1671m
Winders: 2 x 18ft Tower mounted Koepe
Hoisting Capacity: 257,0 ktpm

Ventilation Shaft:

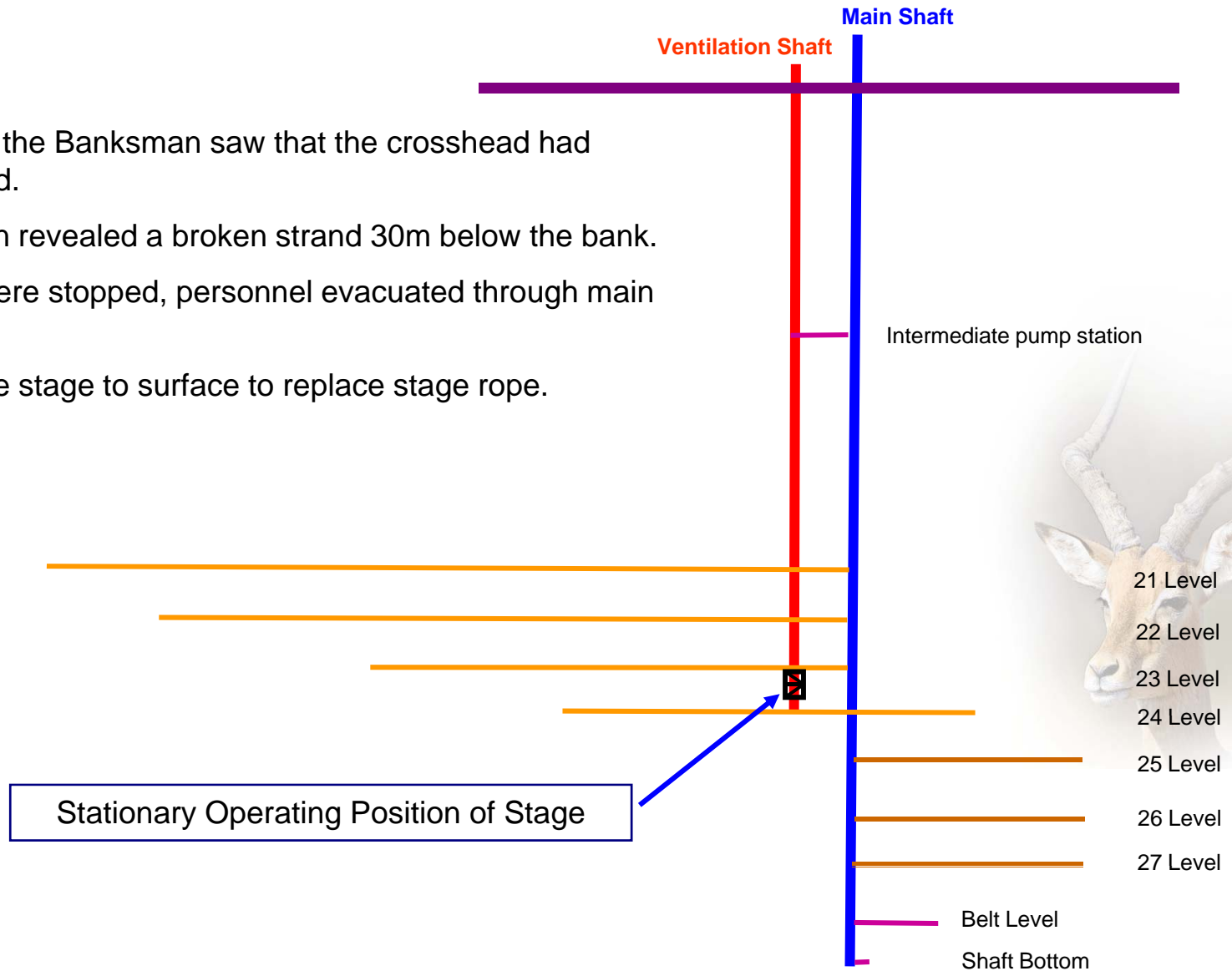
Up-cast ventilation shaft
Shaft diameter: 6.8m
Final depth: -1397m

PROJECT ORIENTATION



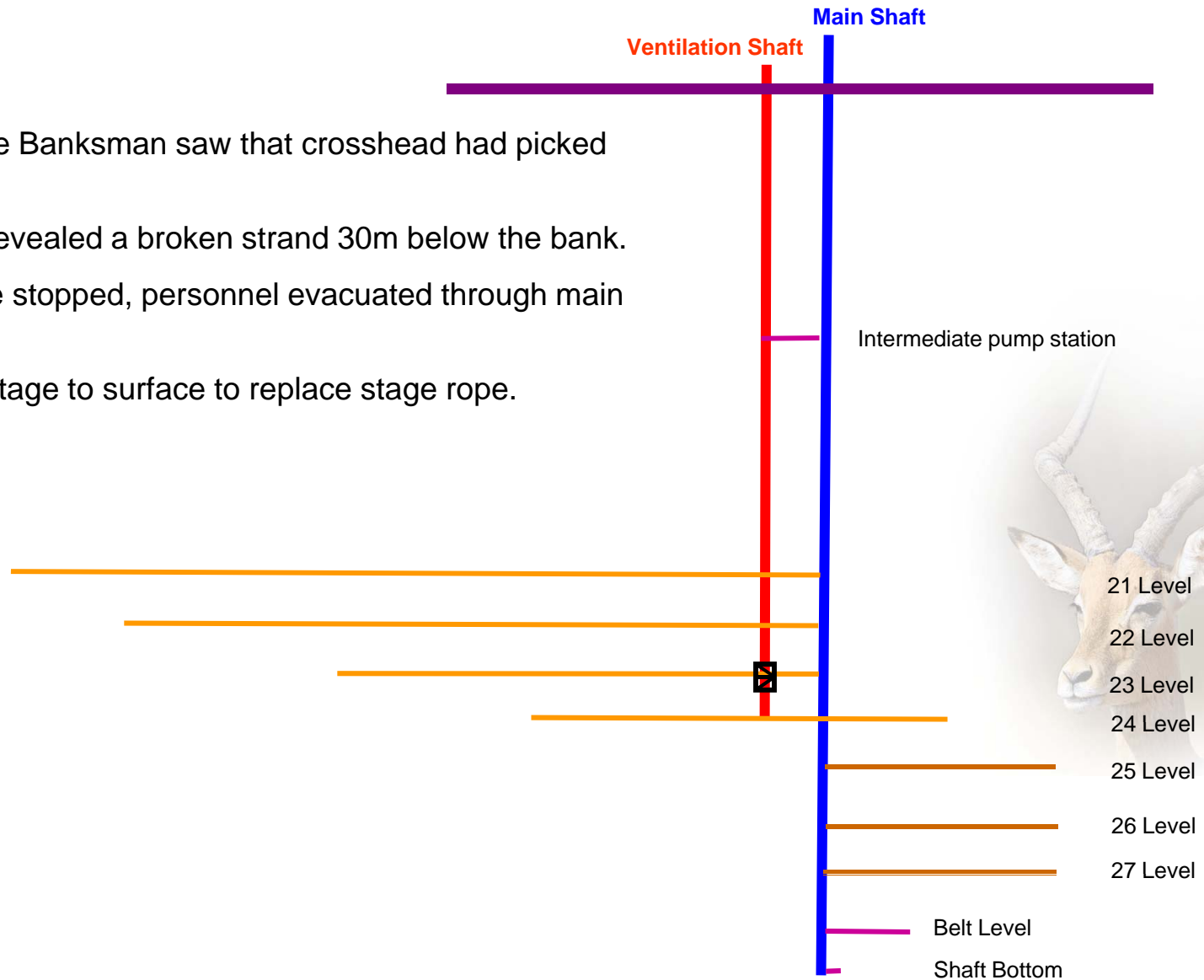
SEQUENCE OF EVENTS

- On 19 February the Banksman saw that the crosshead had picked up a strand.
- Visual inspection revealed a broken strand 30m below the bank.
- All operations were stopped, personnel evacuated through main shaft.
- Decided to move stage to surface to replace stage rope.



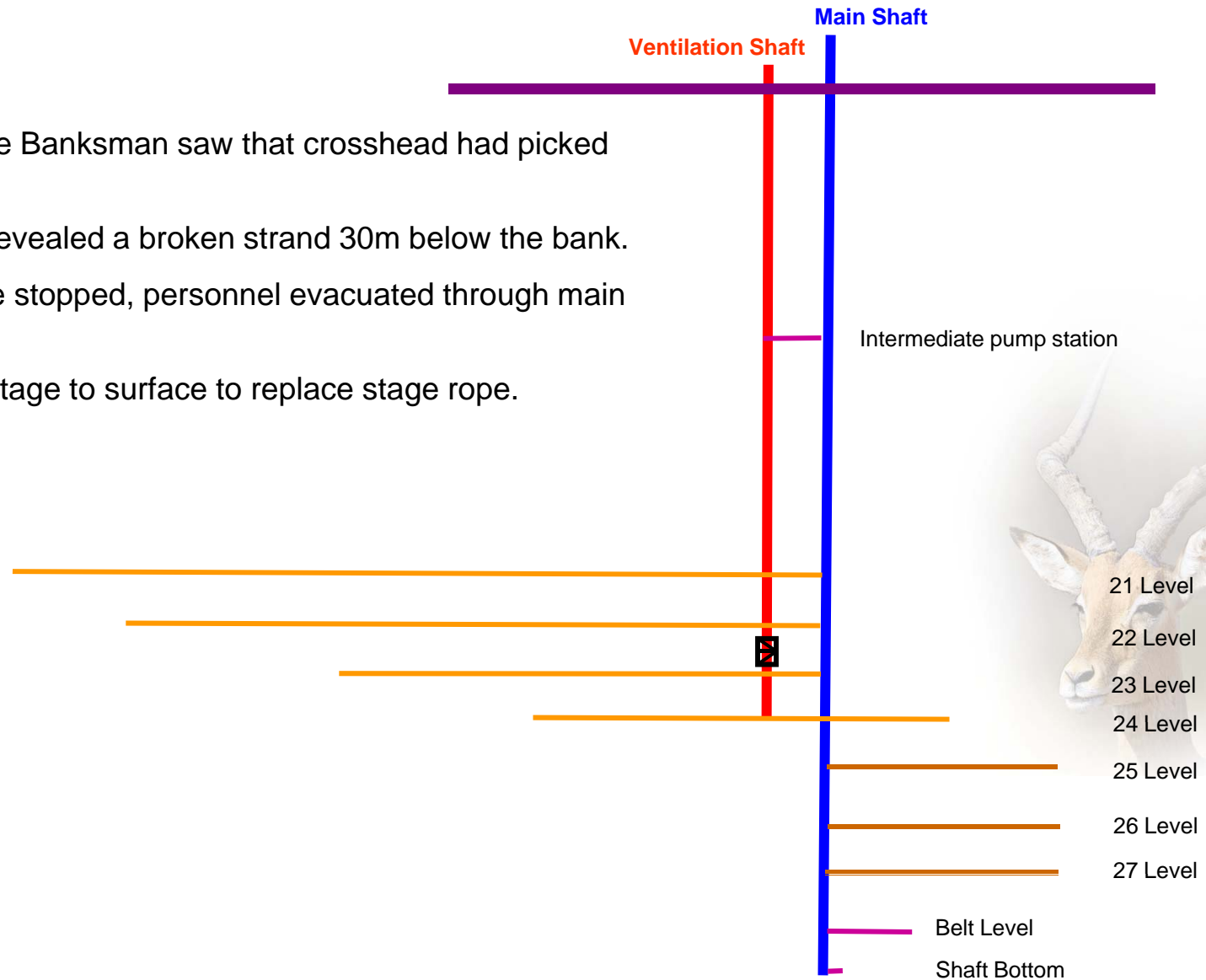
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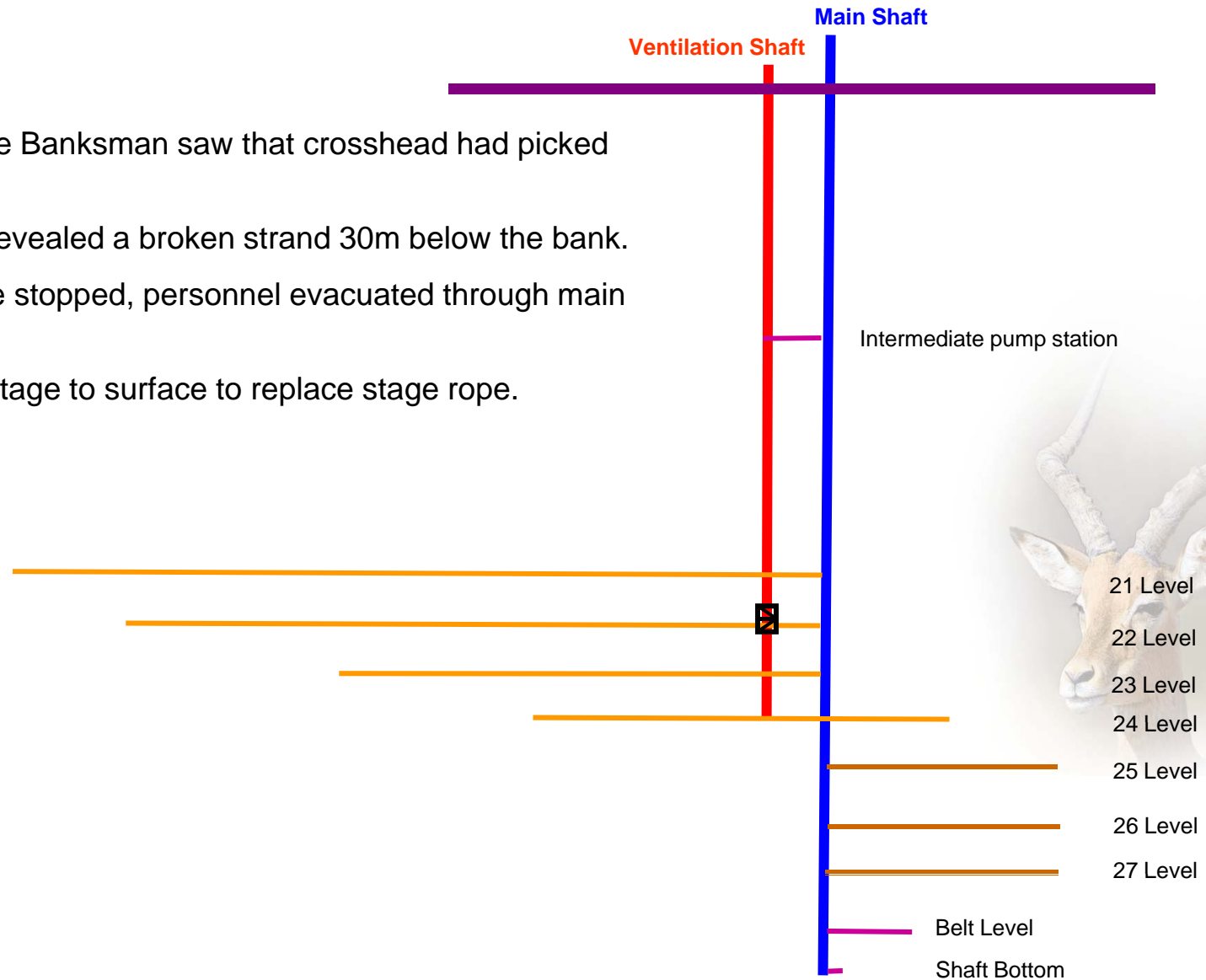
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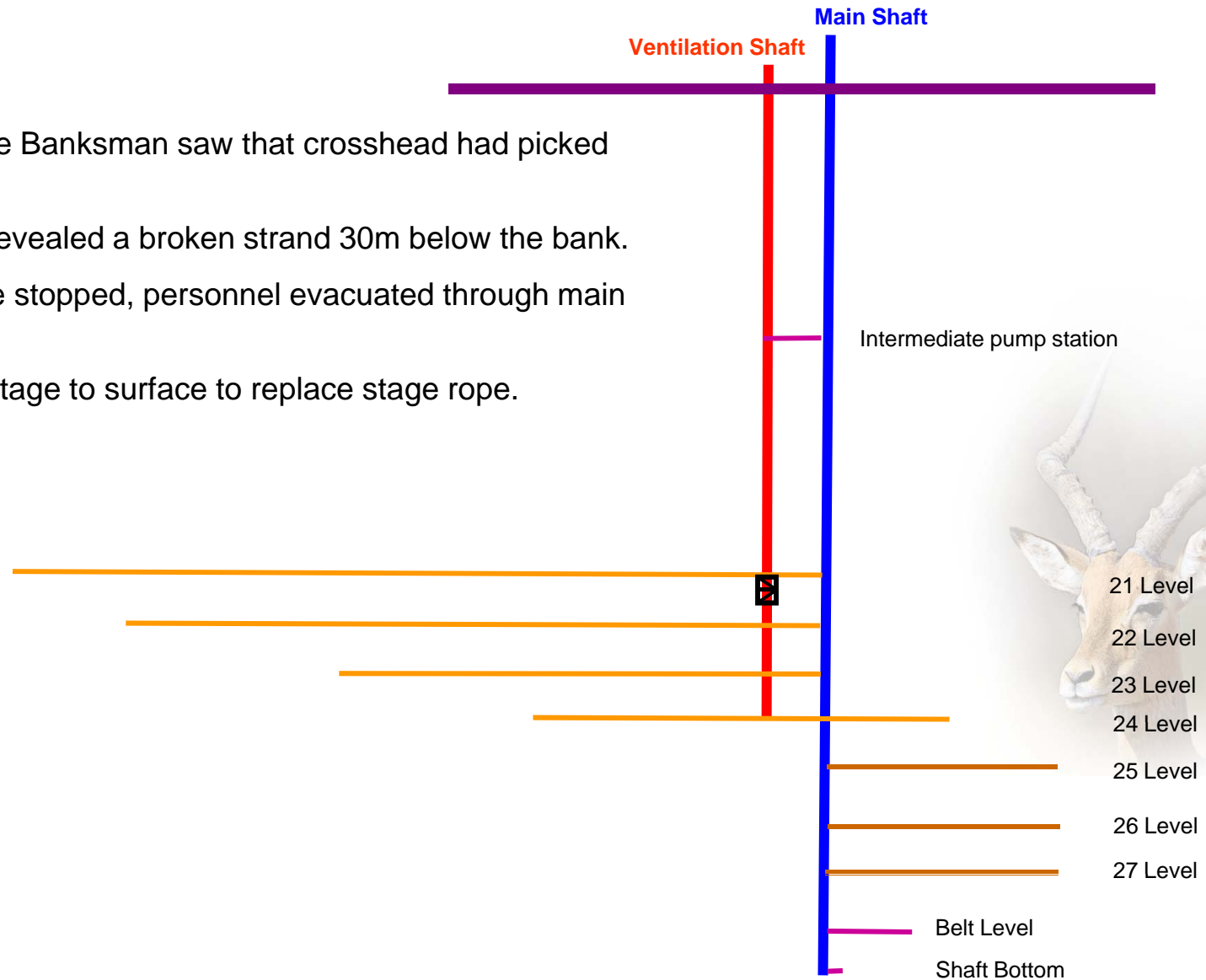
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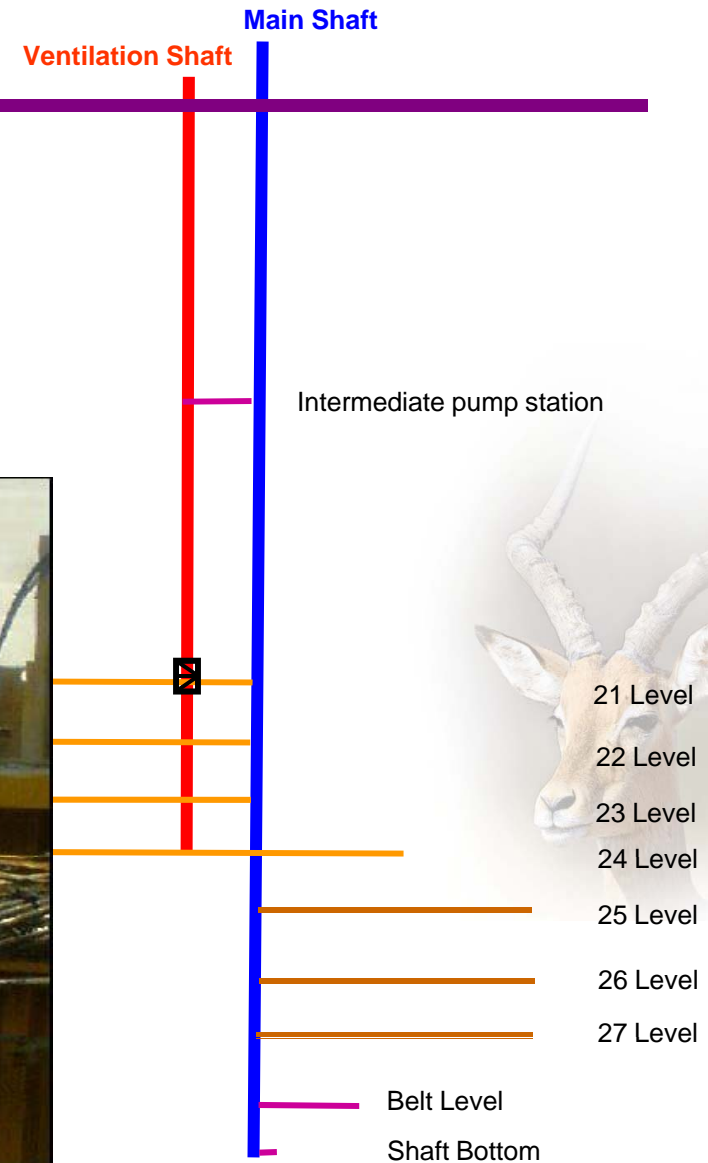
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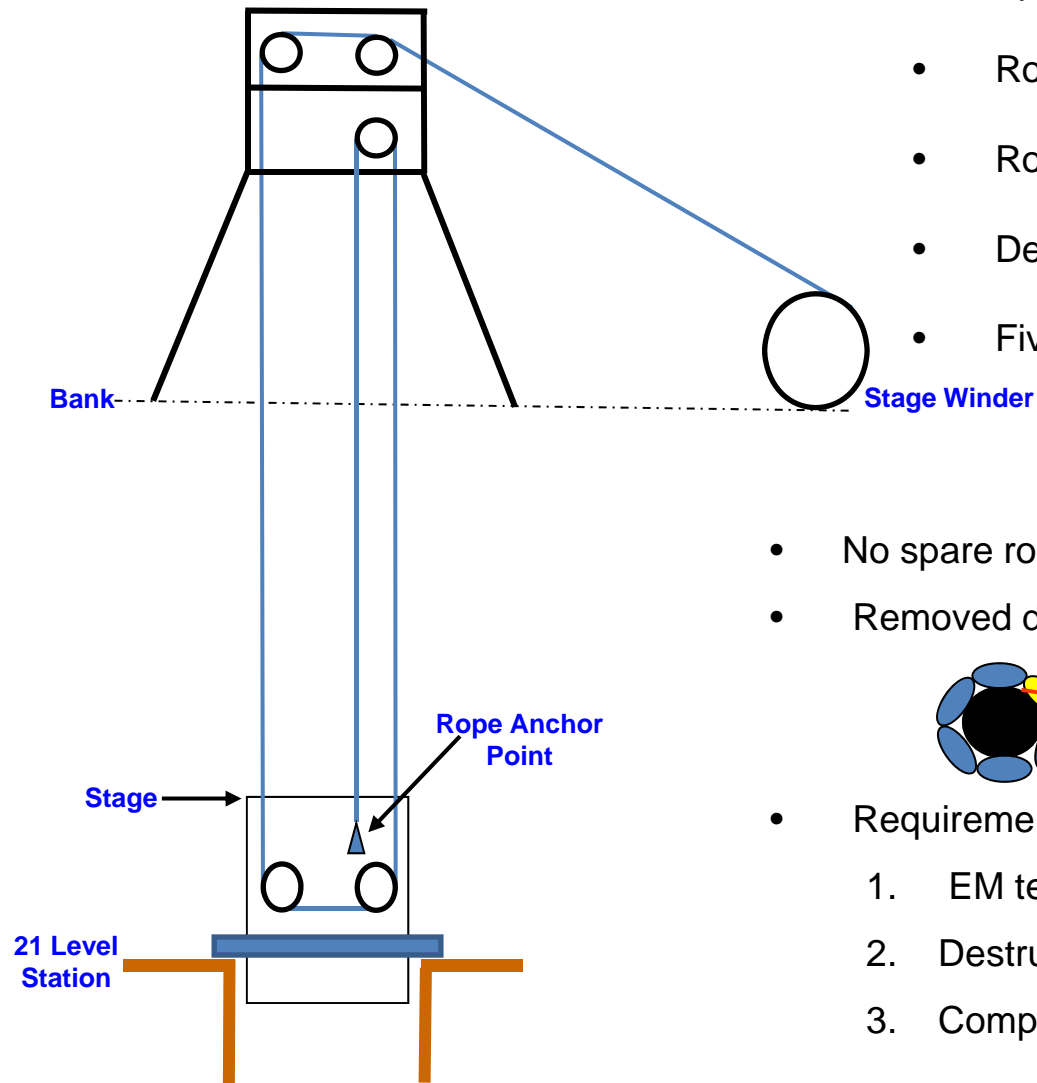
- Engineer instructed the Rigger to visually inspect damaged section of stage rope at frequent intervals.
- Further deterioration of the rope necessitated stage to be secured on 21 level



STAGE SUSPENSION BEAMS



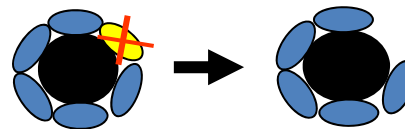
EQUIPMENT DESCRIPTION



- Stage is suspended with 2 x 34mm ropes - 3 falls per rope.
- Rope construction: 9x6/6x10 (7/3T)/WMC Fish back
- Rope length: 4500 metres
- Dead-ends of each rope anchored on the stage.
- Five deck stage with a total mass of 63 tonnes.

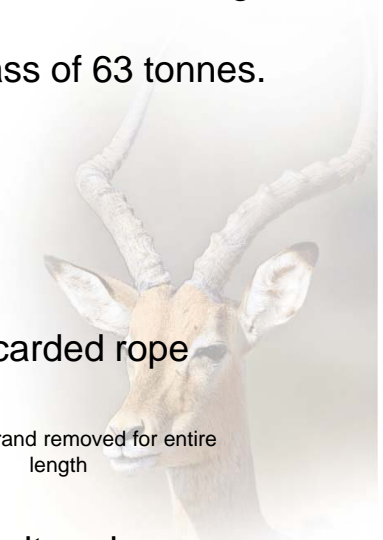
New Rope:

- No spare rope available
- Removed damaged strand from old discarded rope

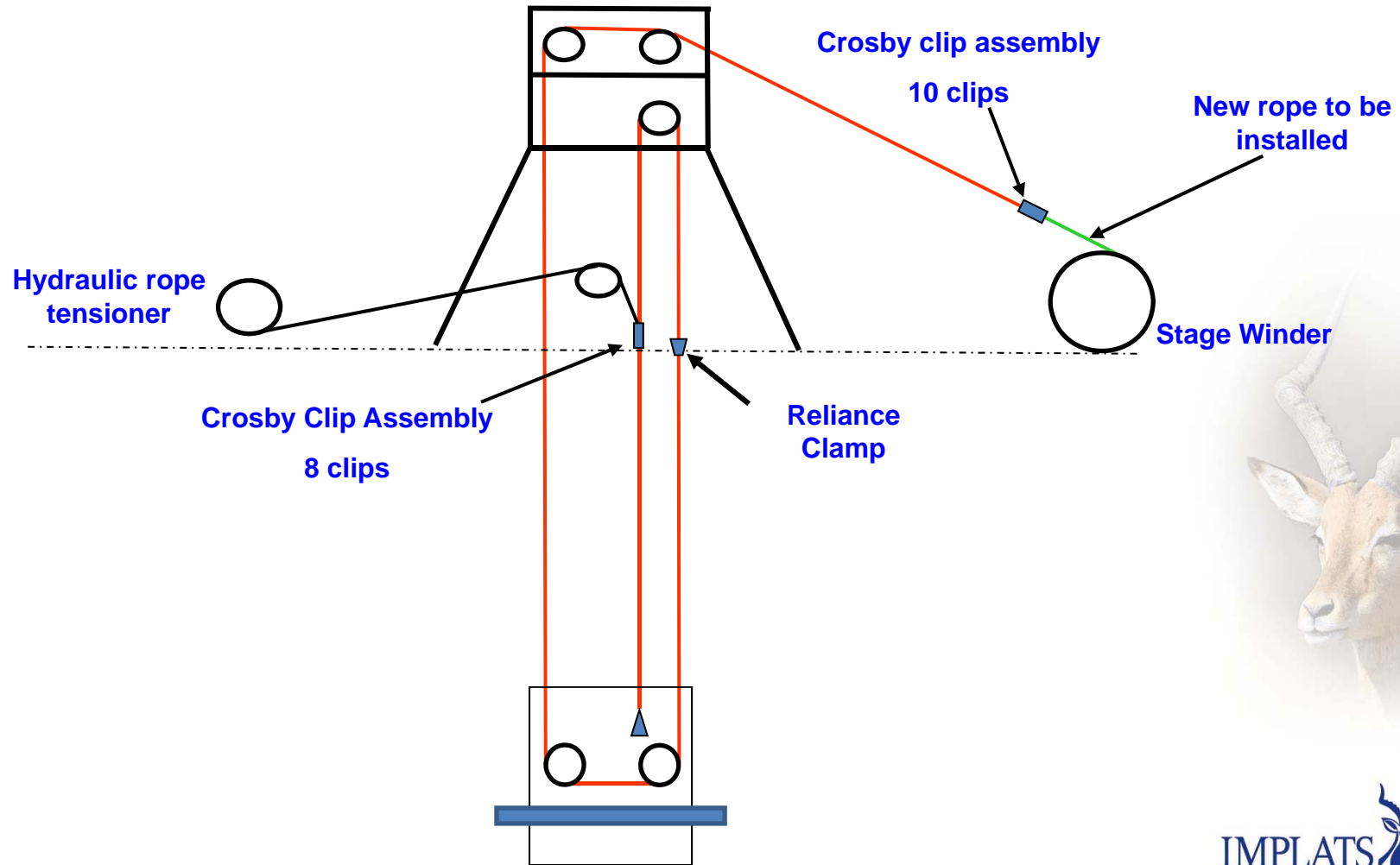


1 Outer strand removed for entire length

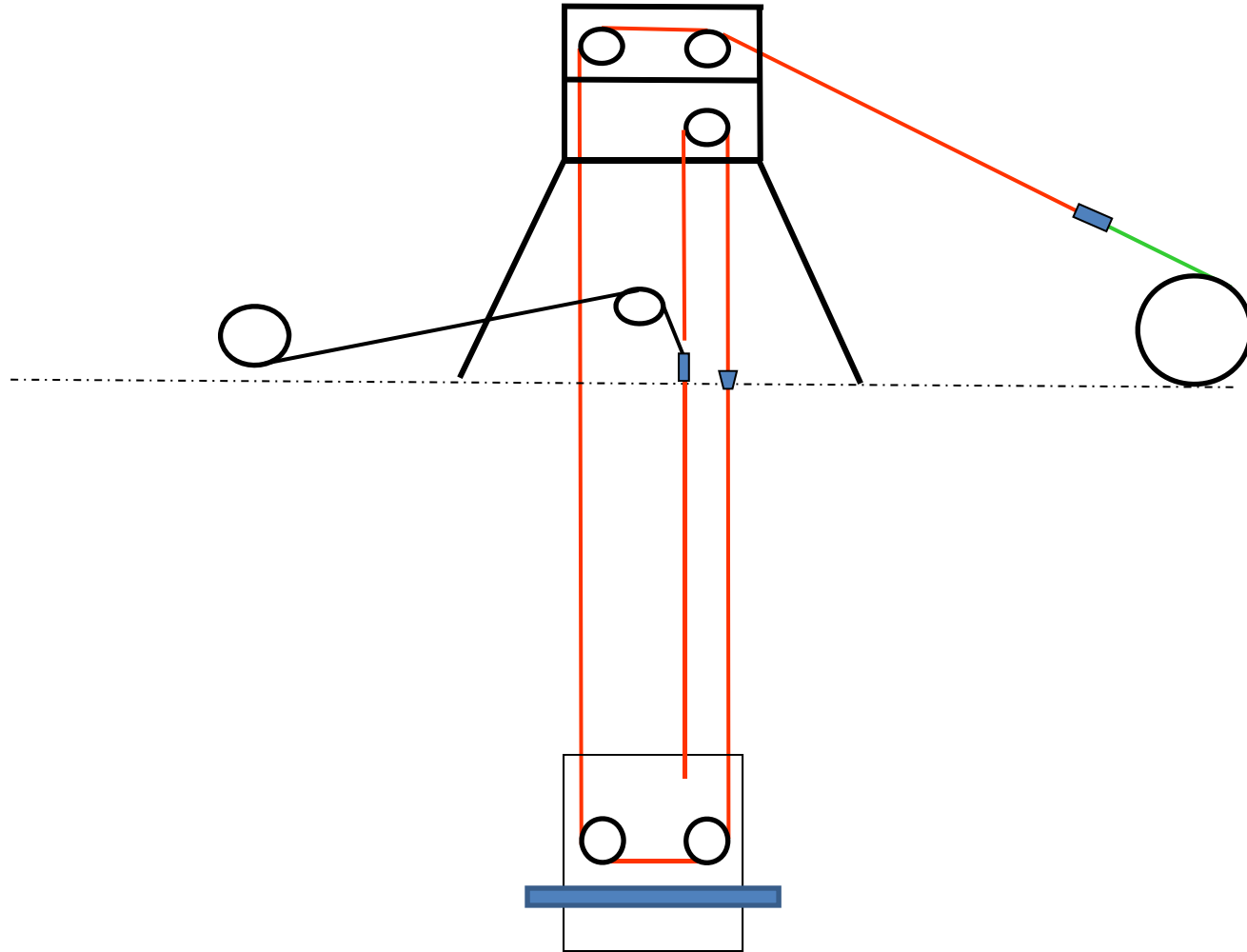
- Requirements for DME approval to use altered rope:
 1. EM test to prove condition.
 2. Destructive test to prove breaking strength.
 3. Comply with the Static Factor as prescribed.



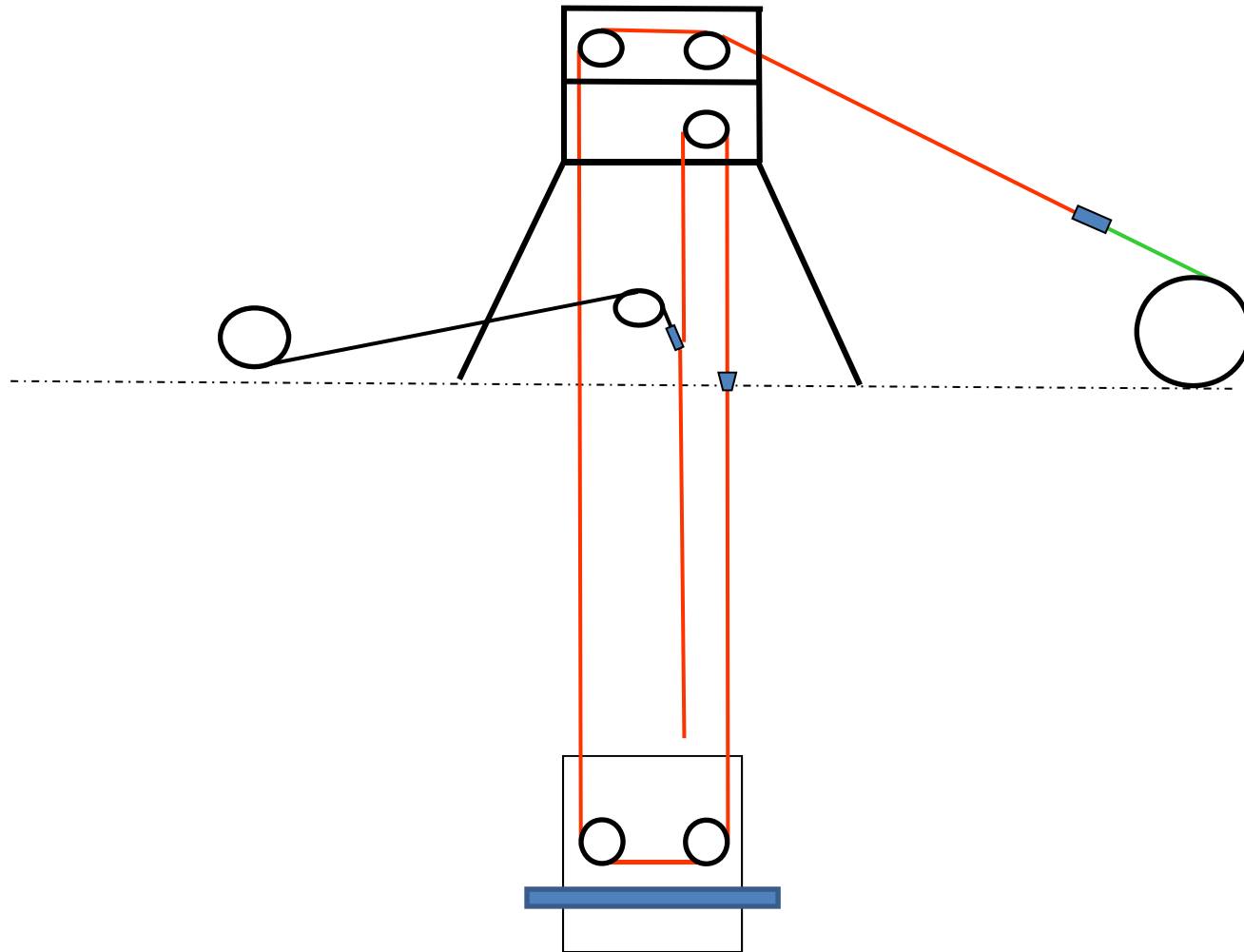
ROPE-UP LAYOUT



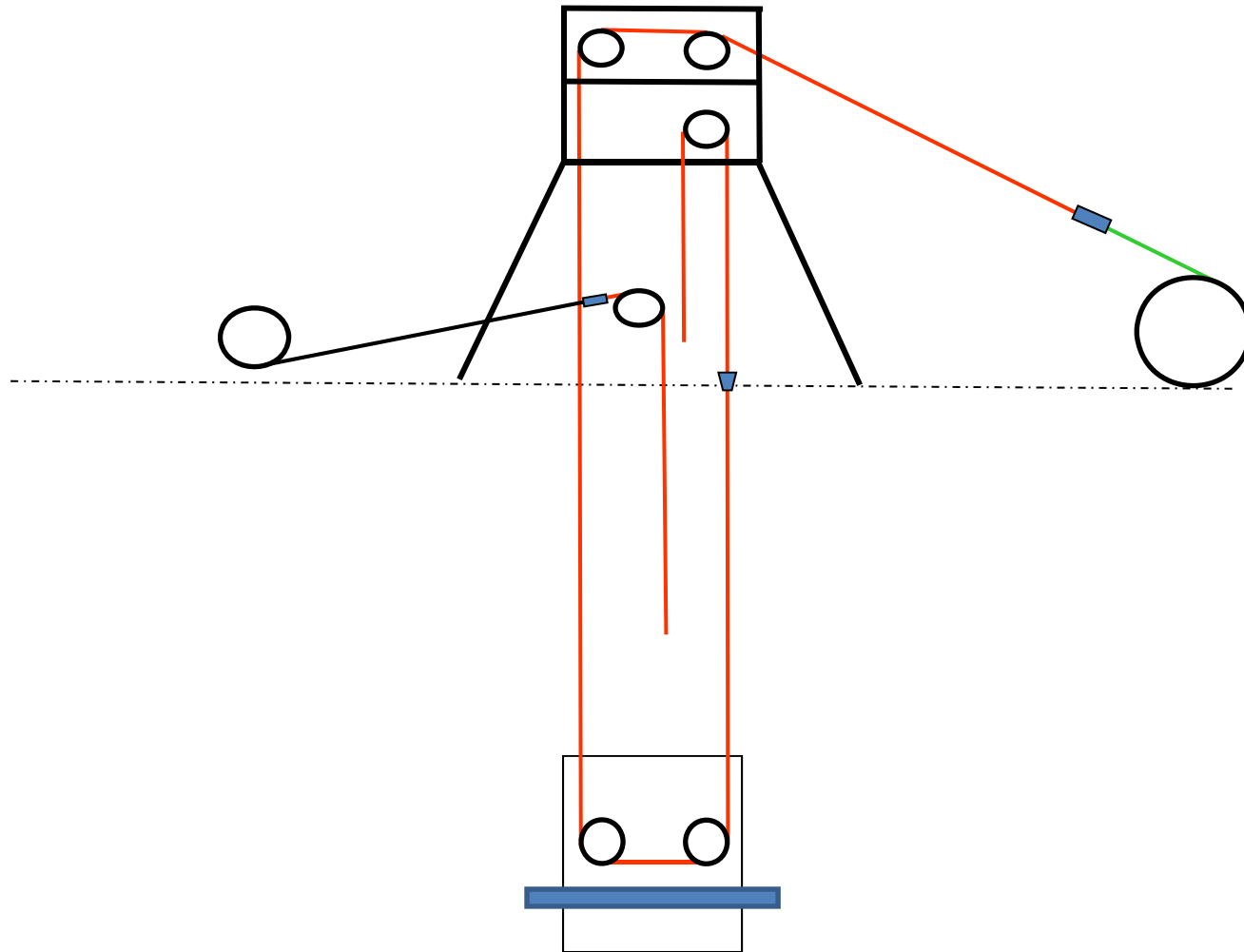
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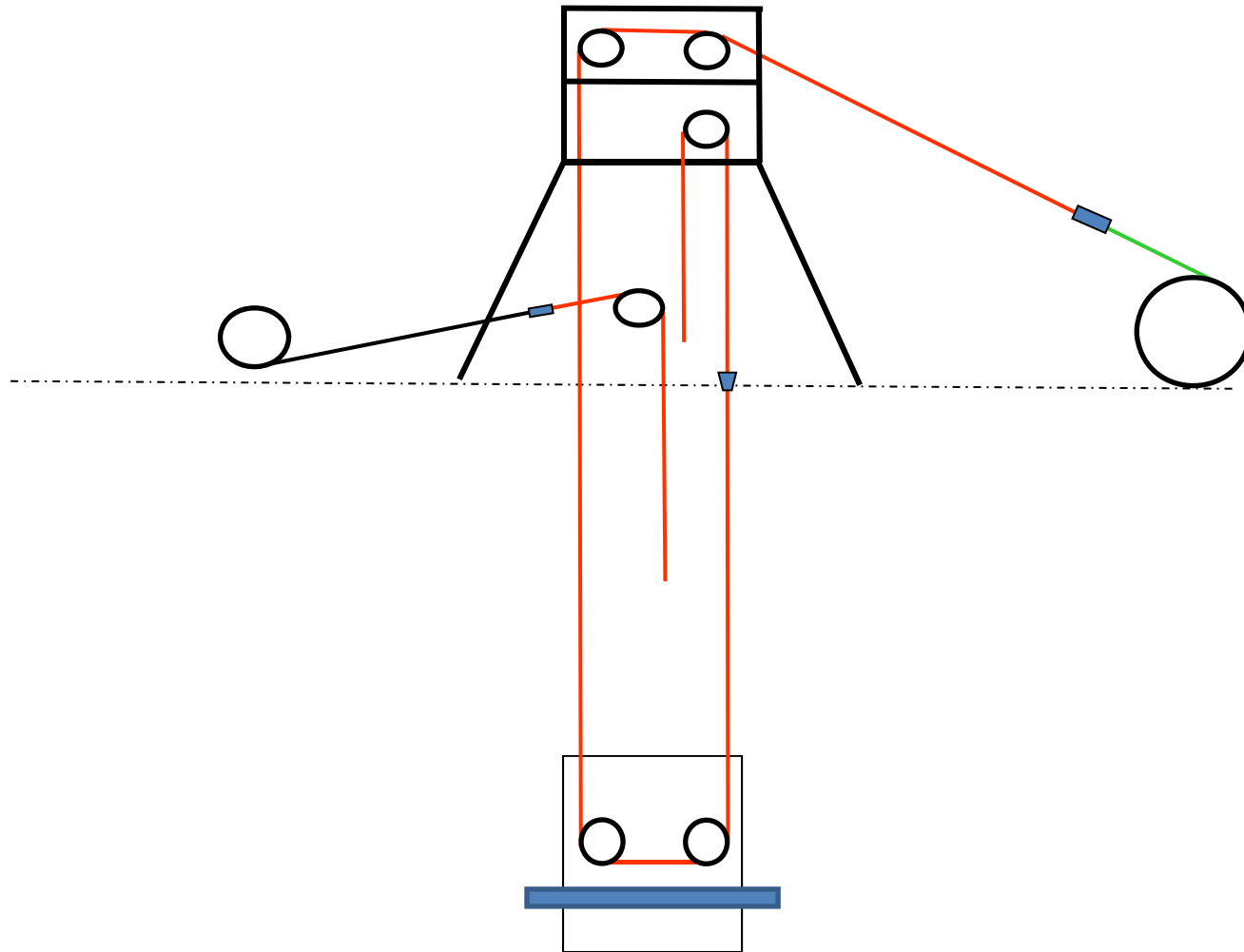
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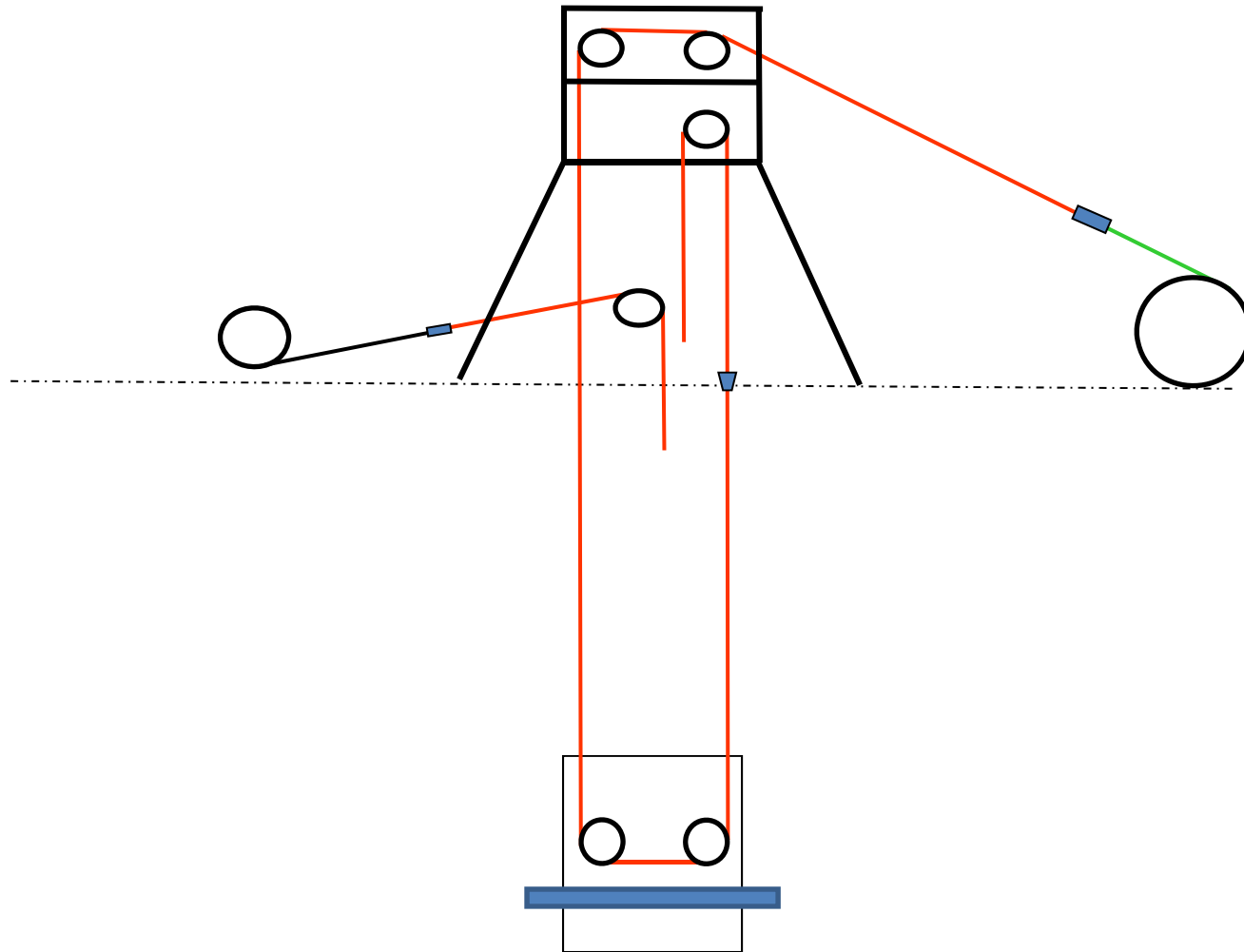
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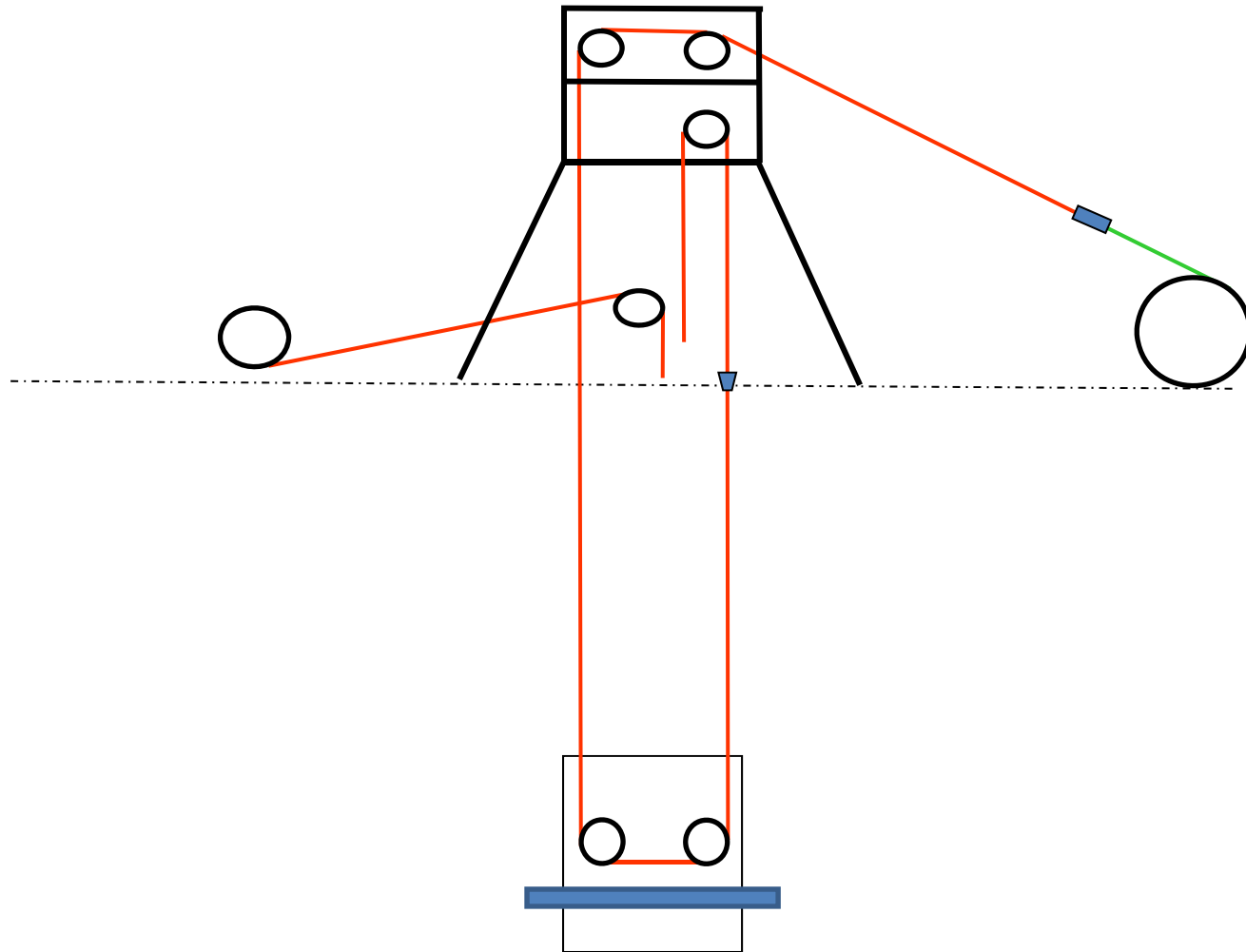
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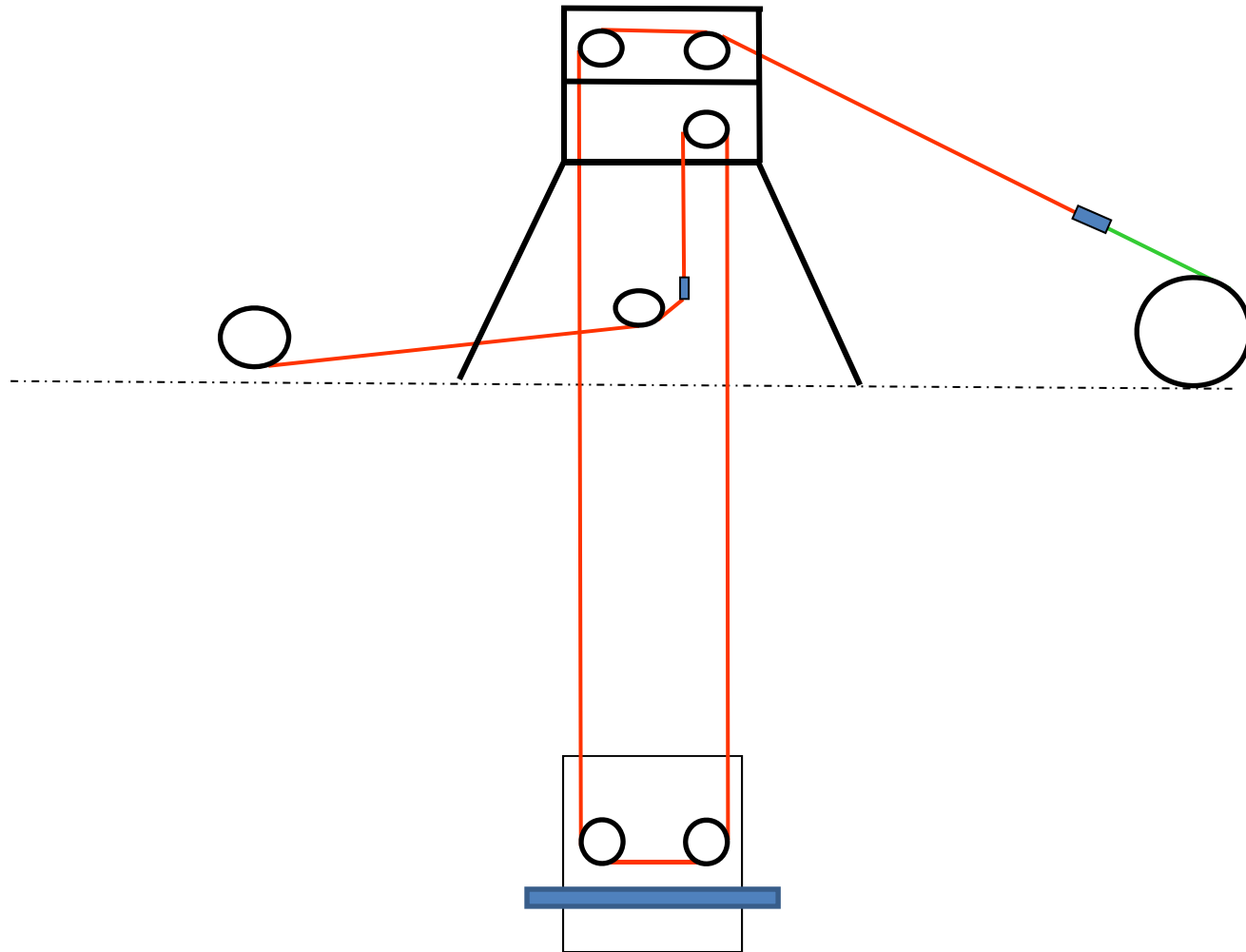
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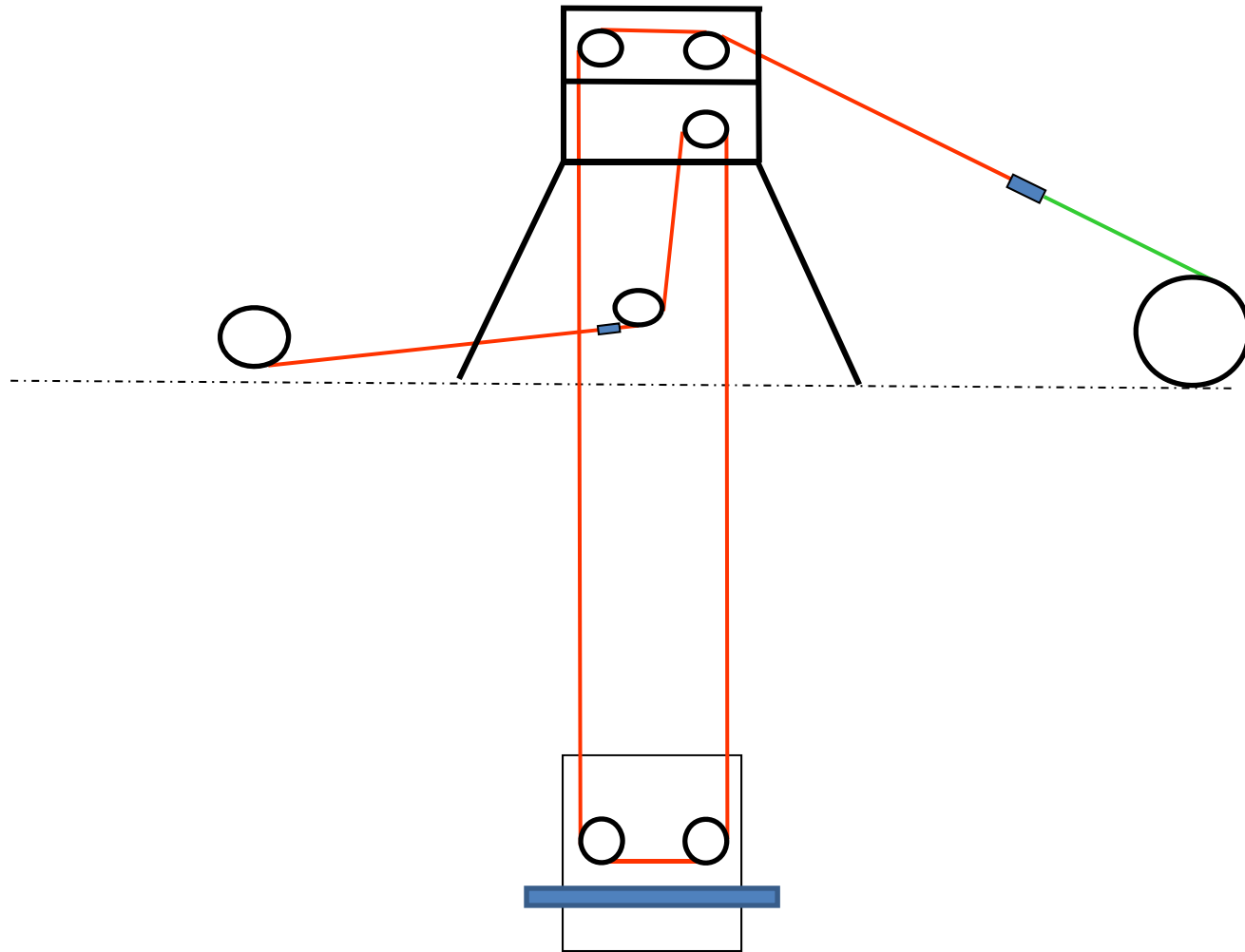
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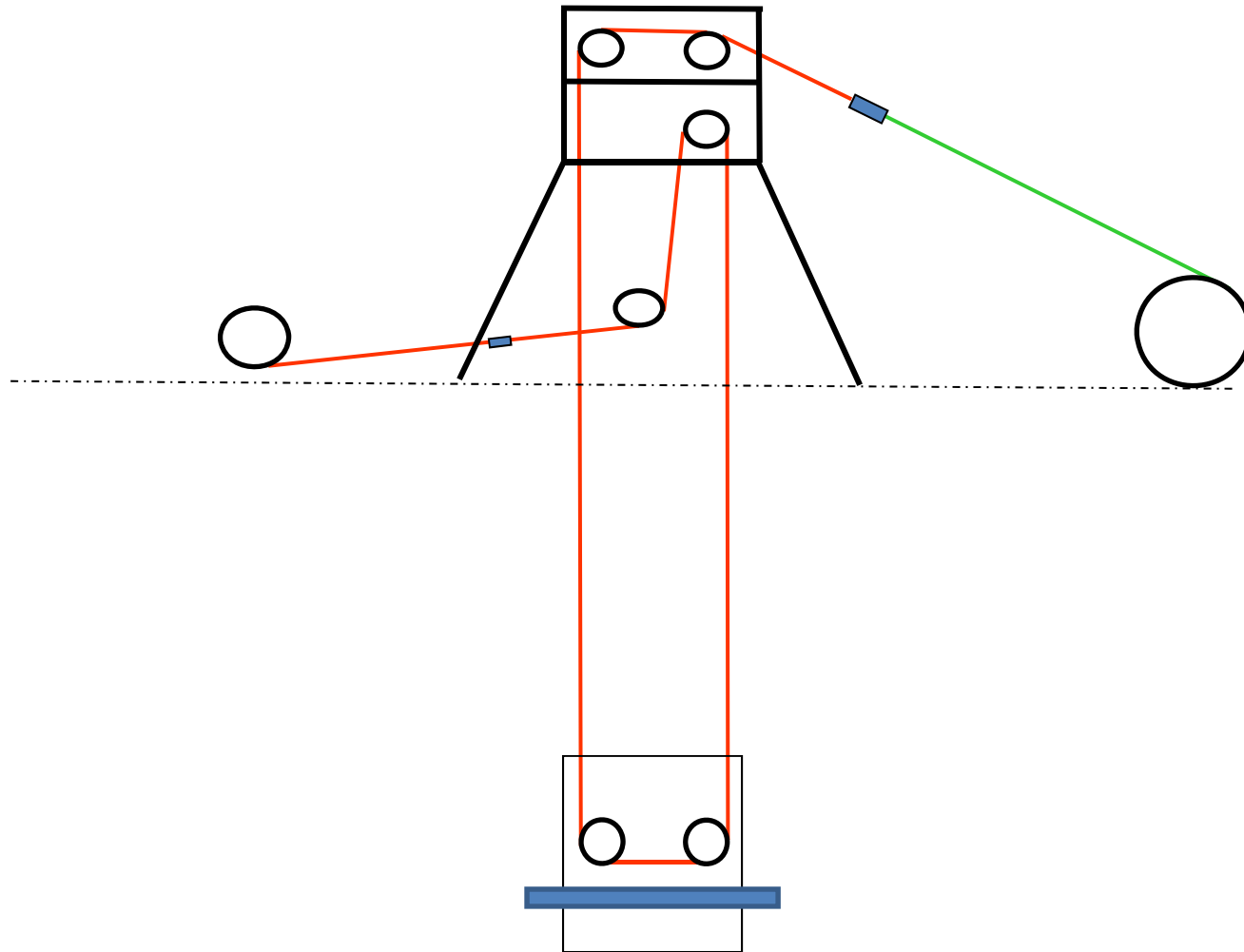
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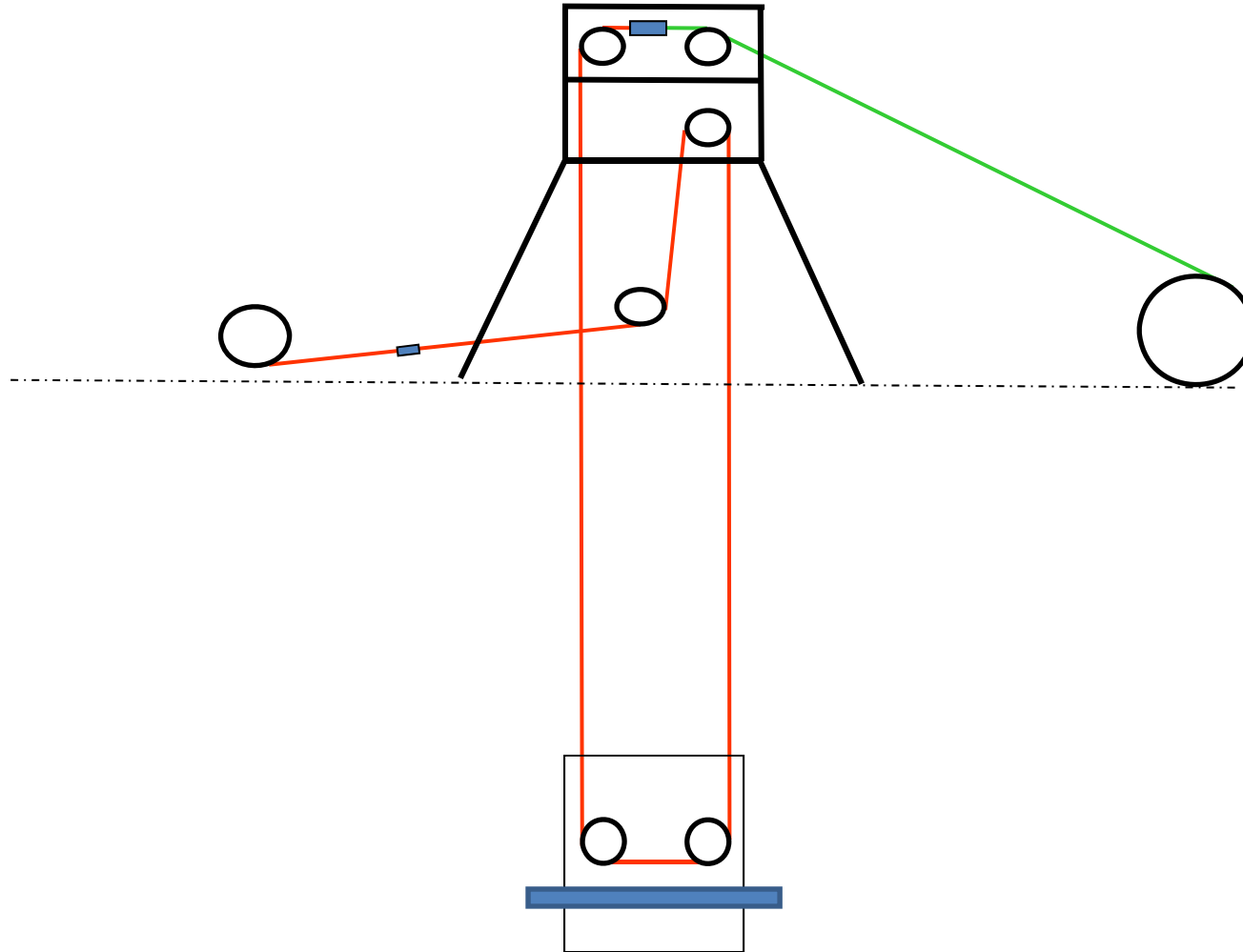
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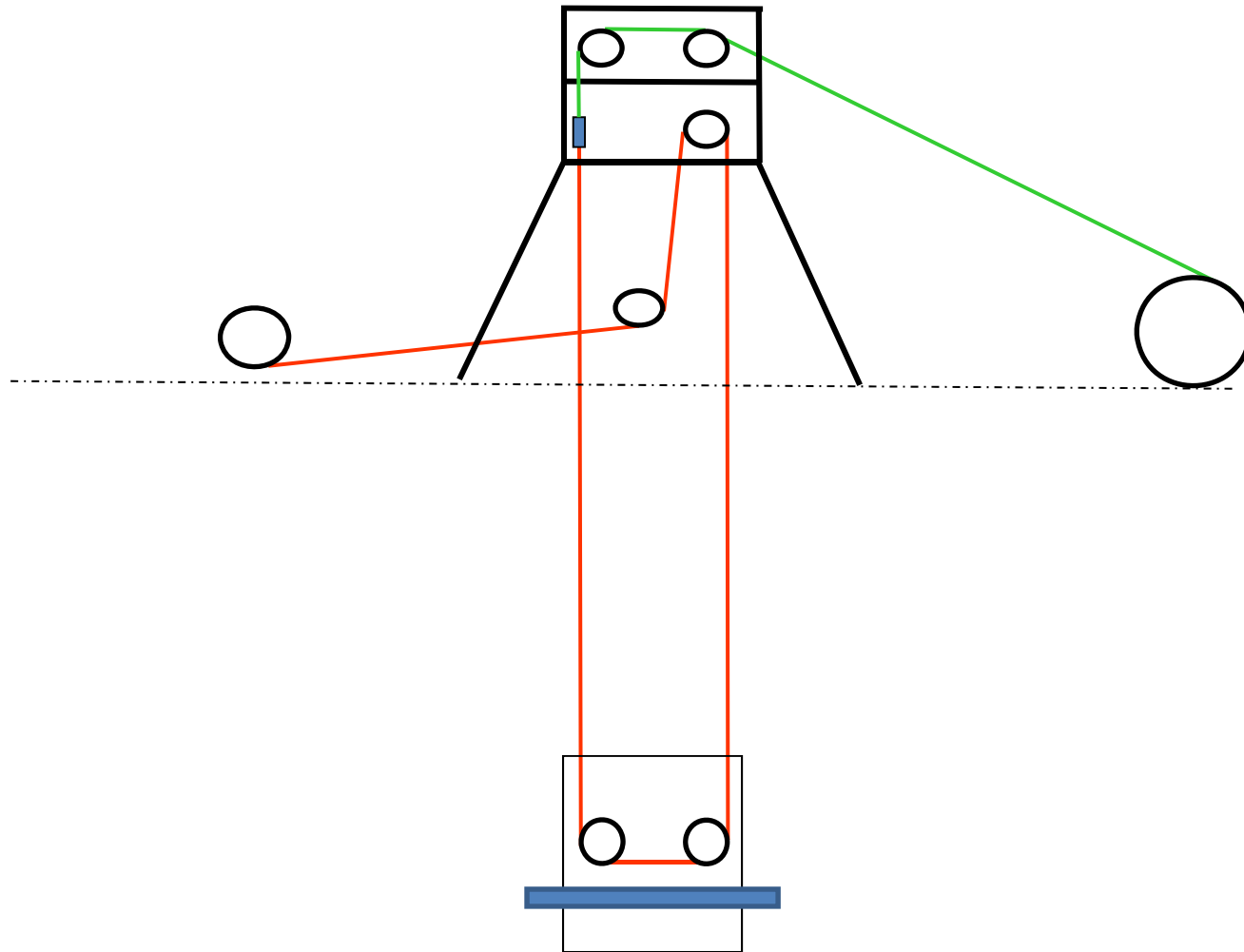
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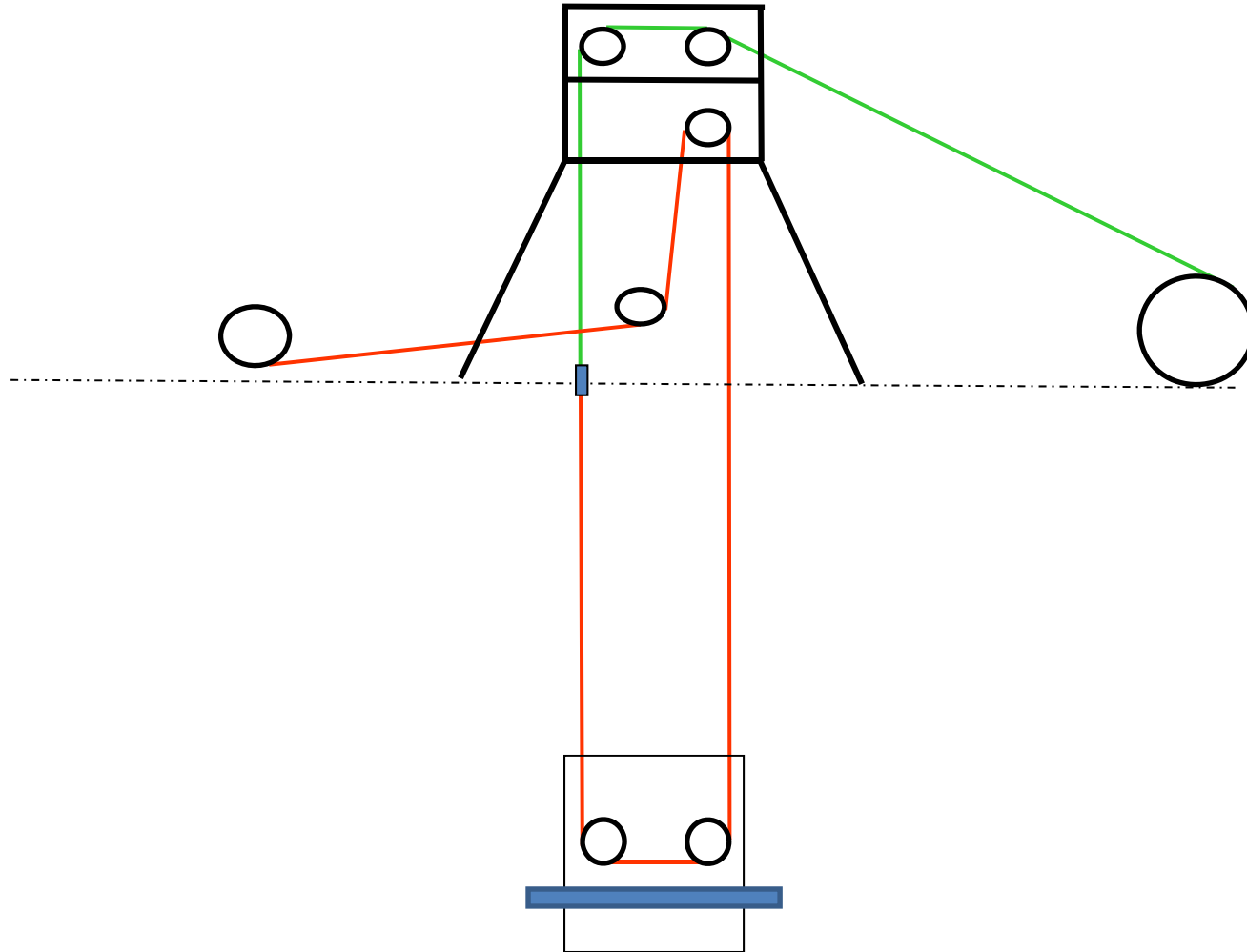
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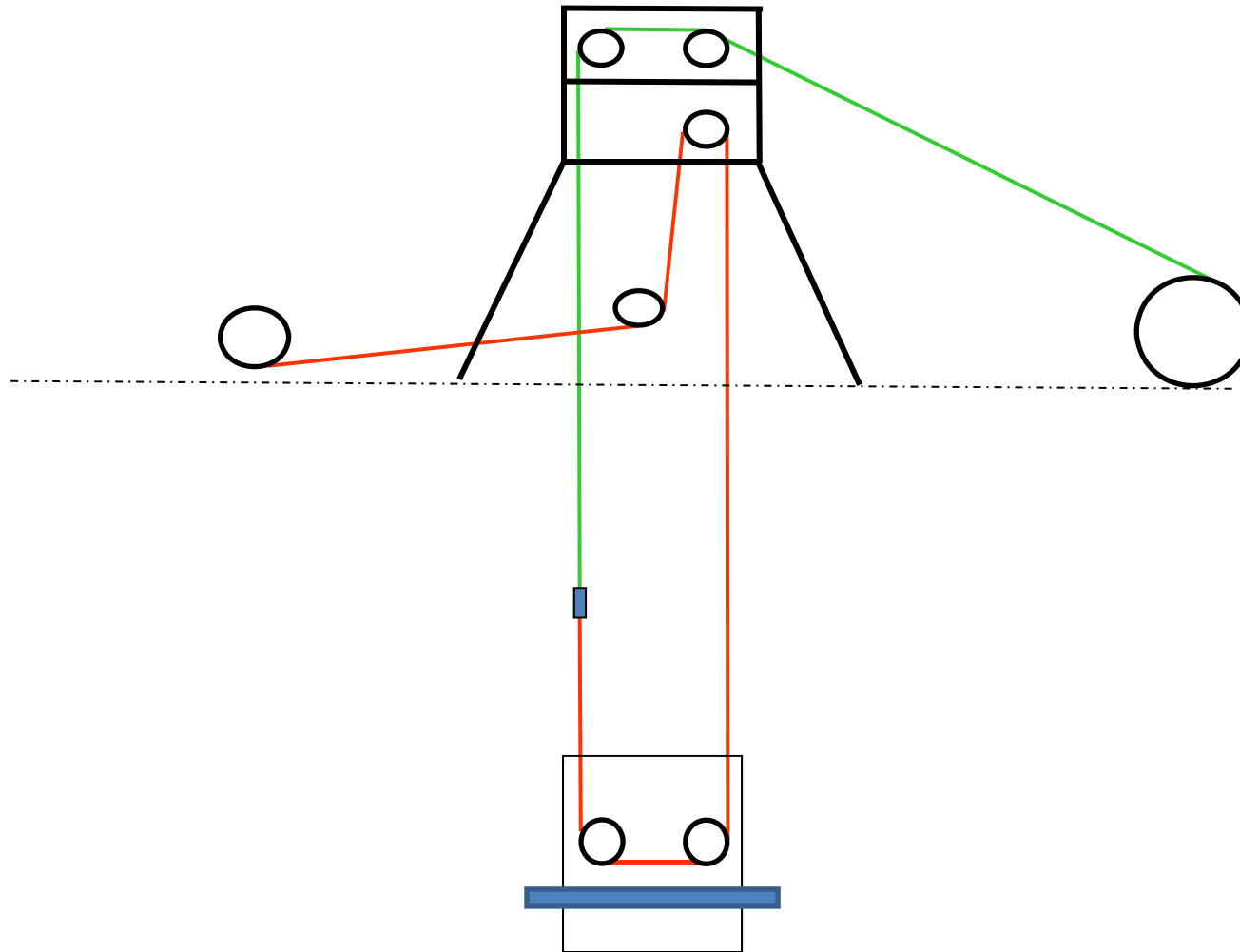
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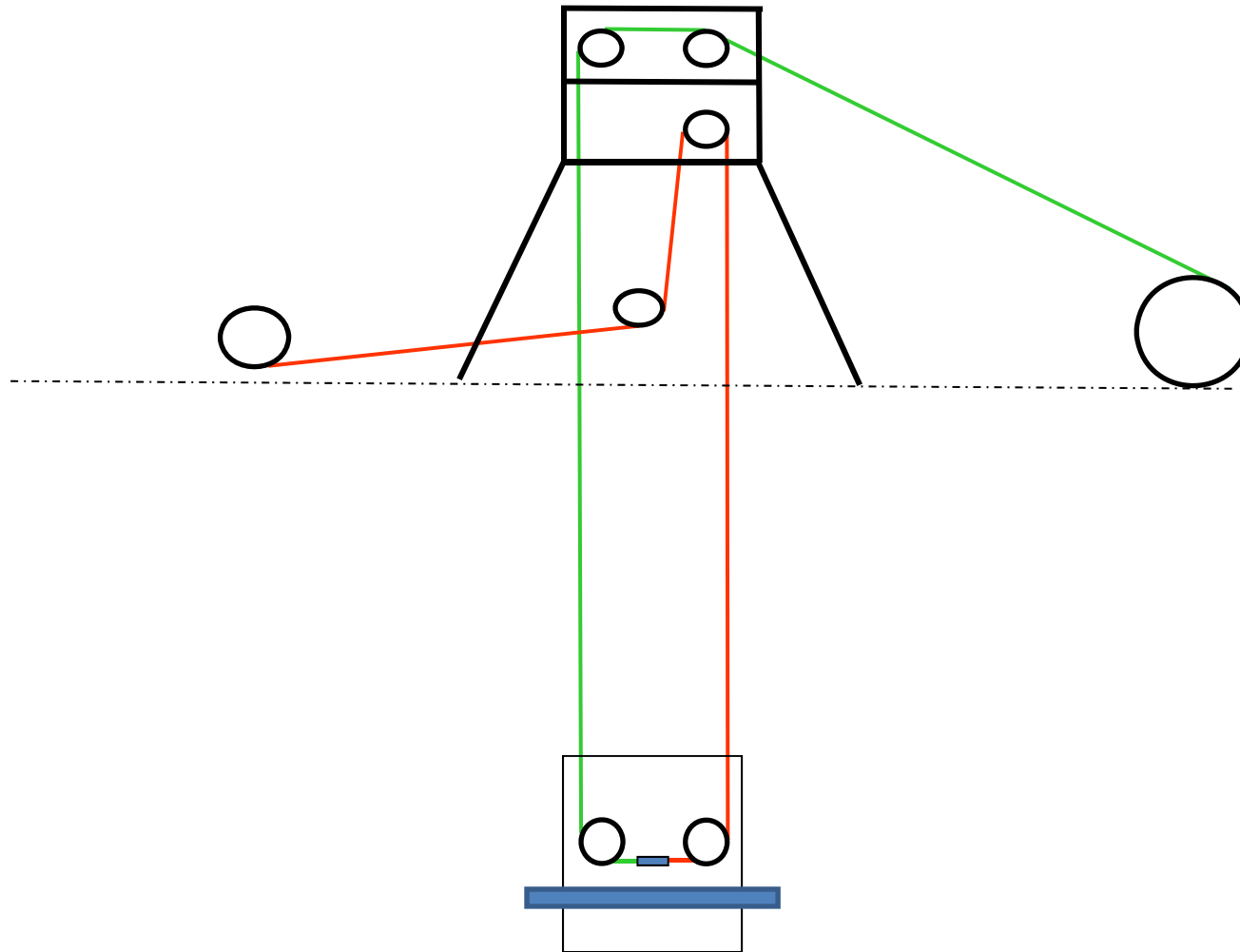
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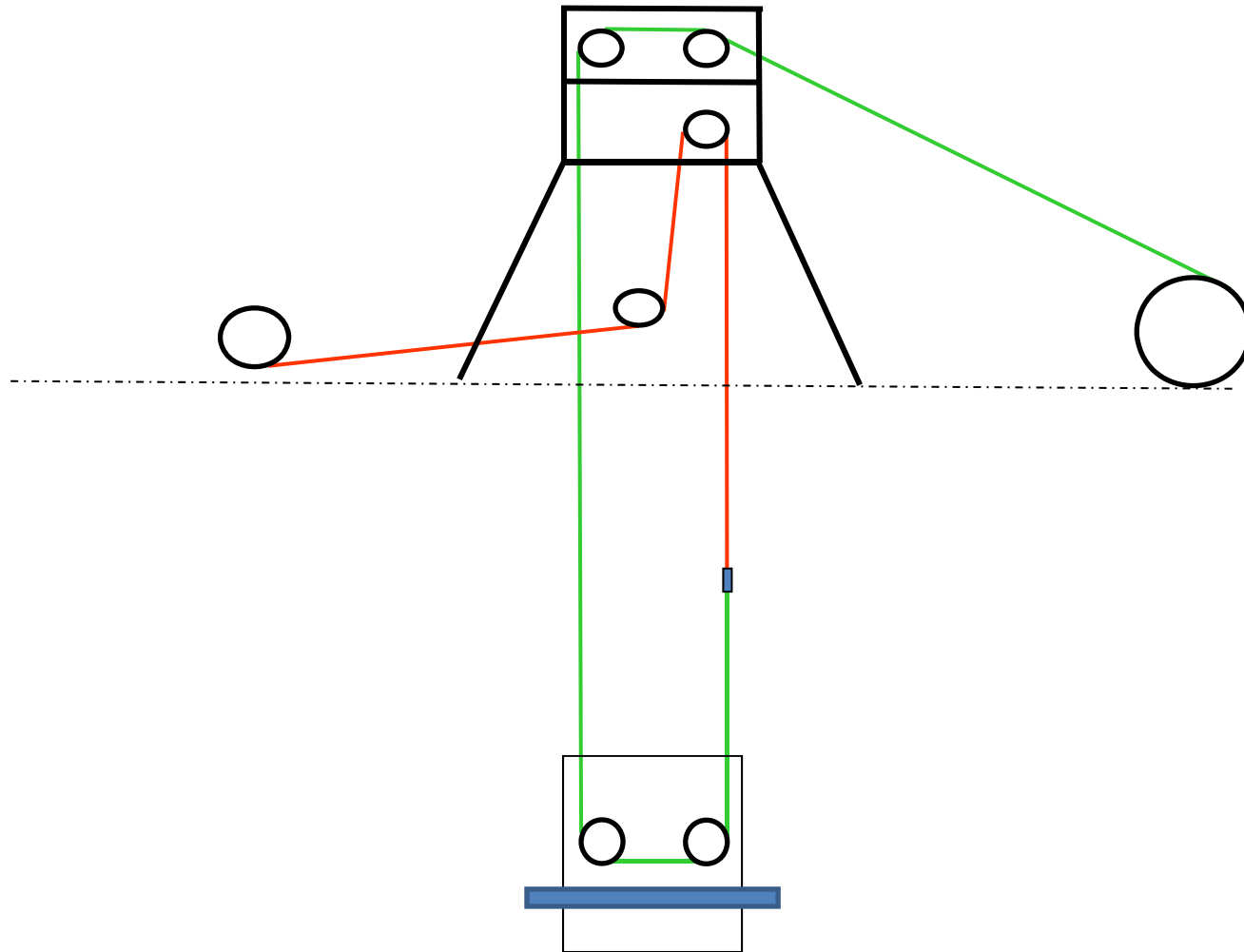
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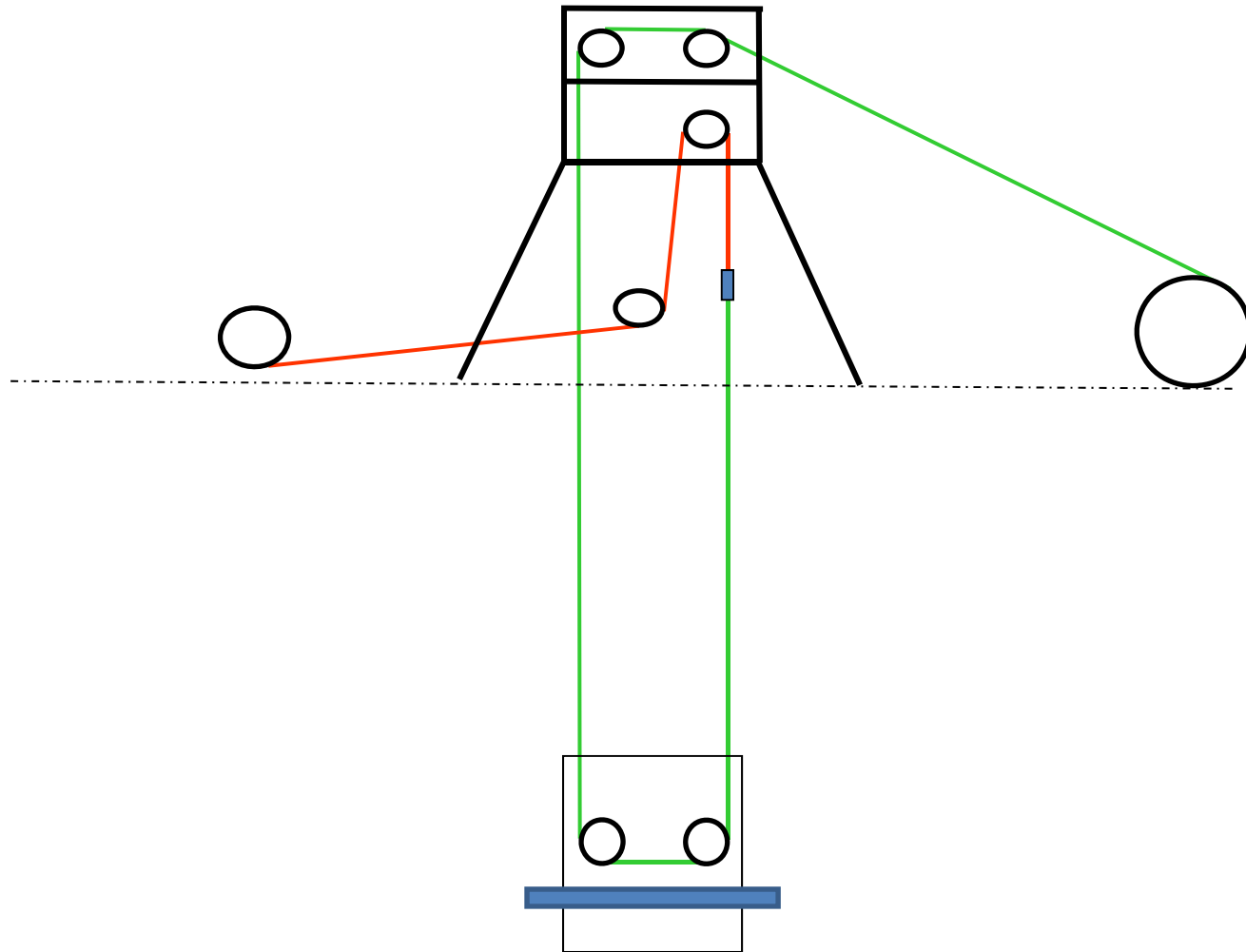
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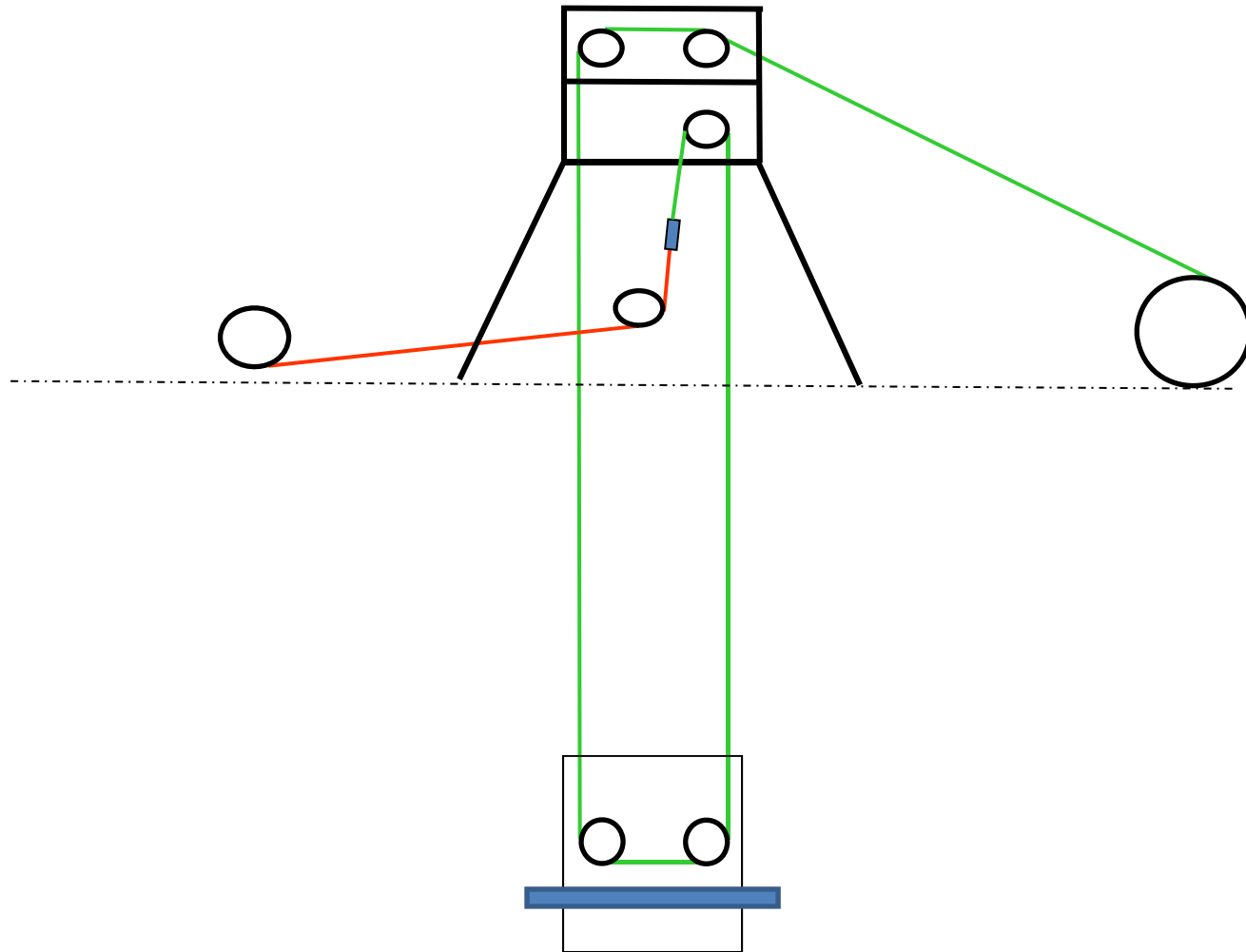
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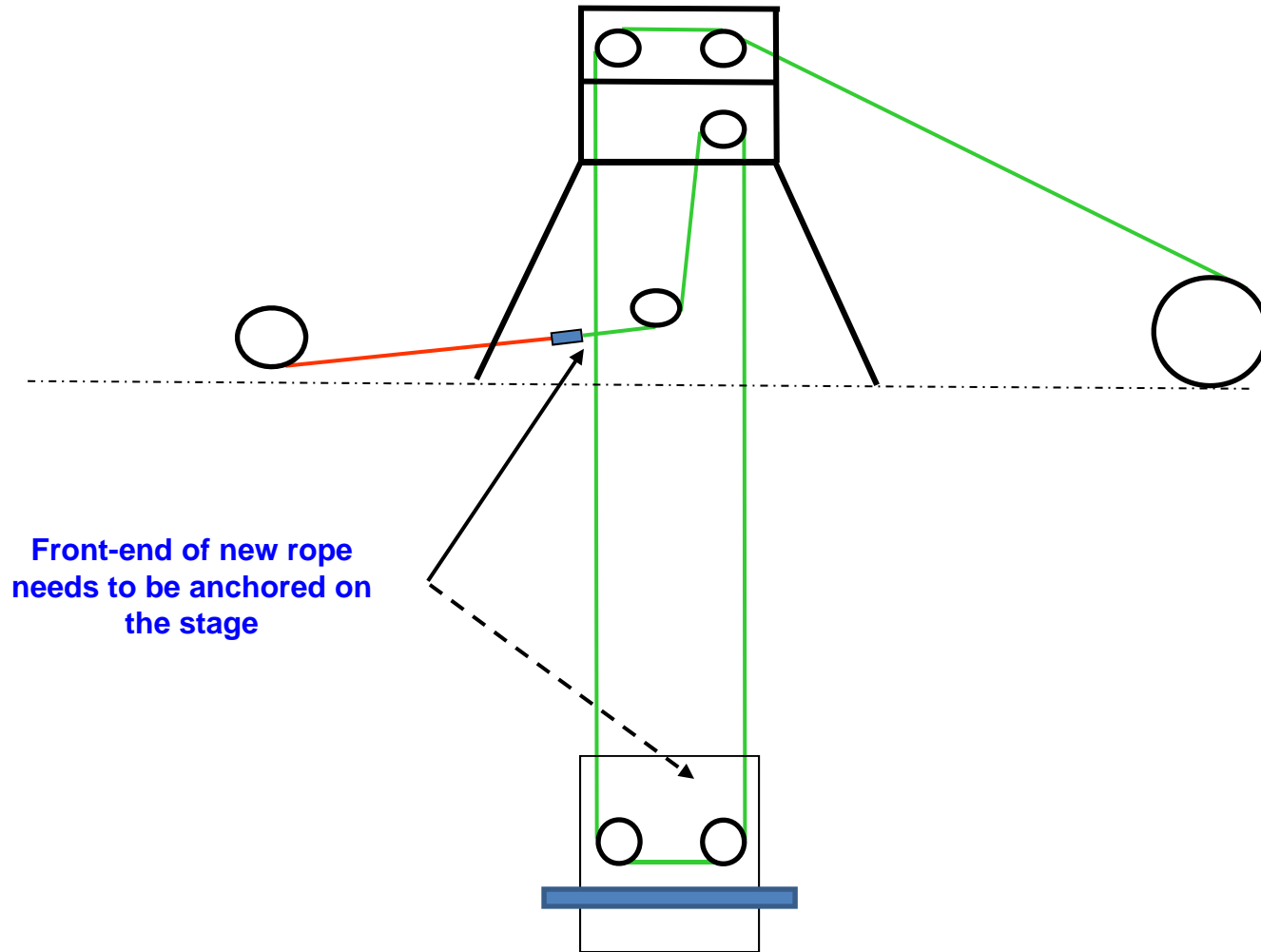
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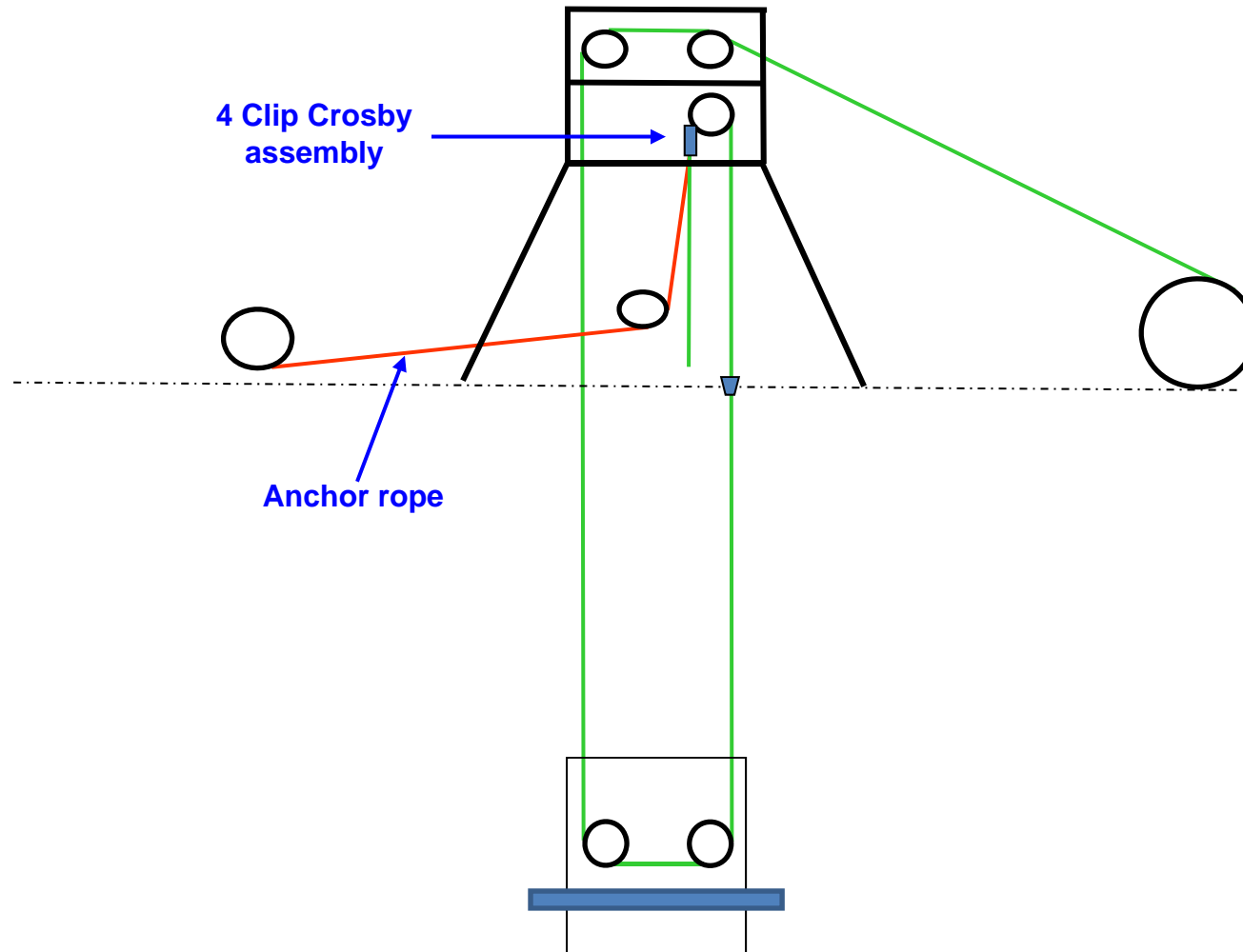
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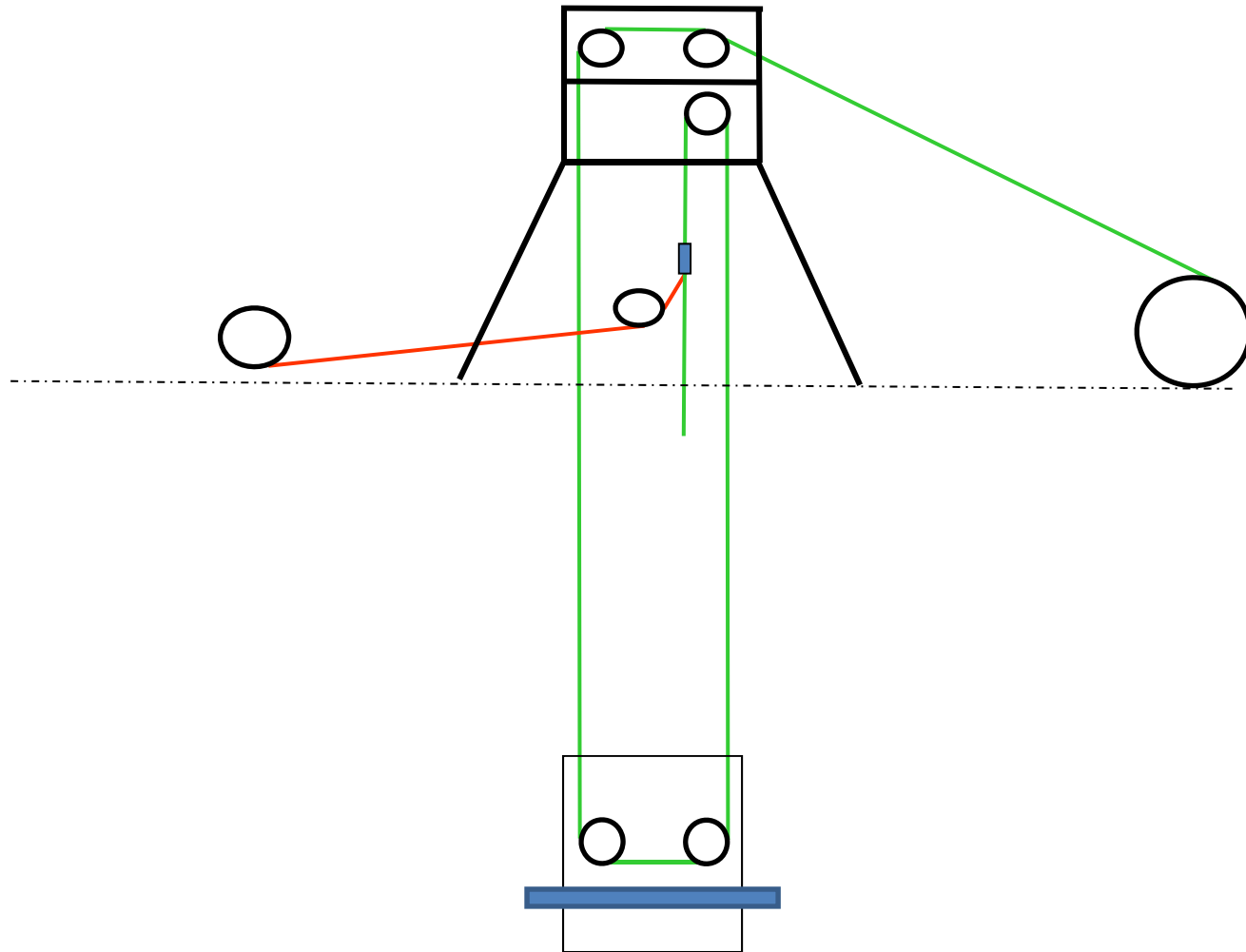
Front-end of new rope
needs to be anchored on
the stage



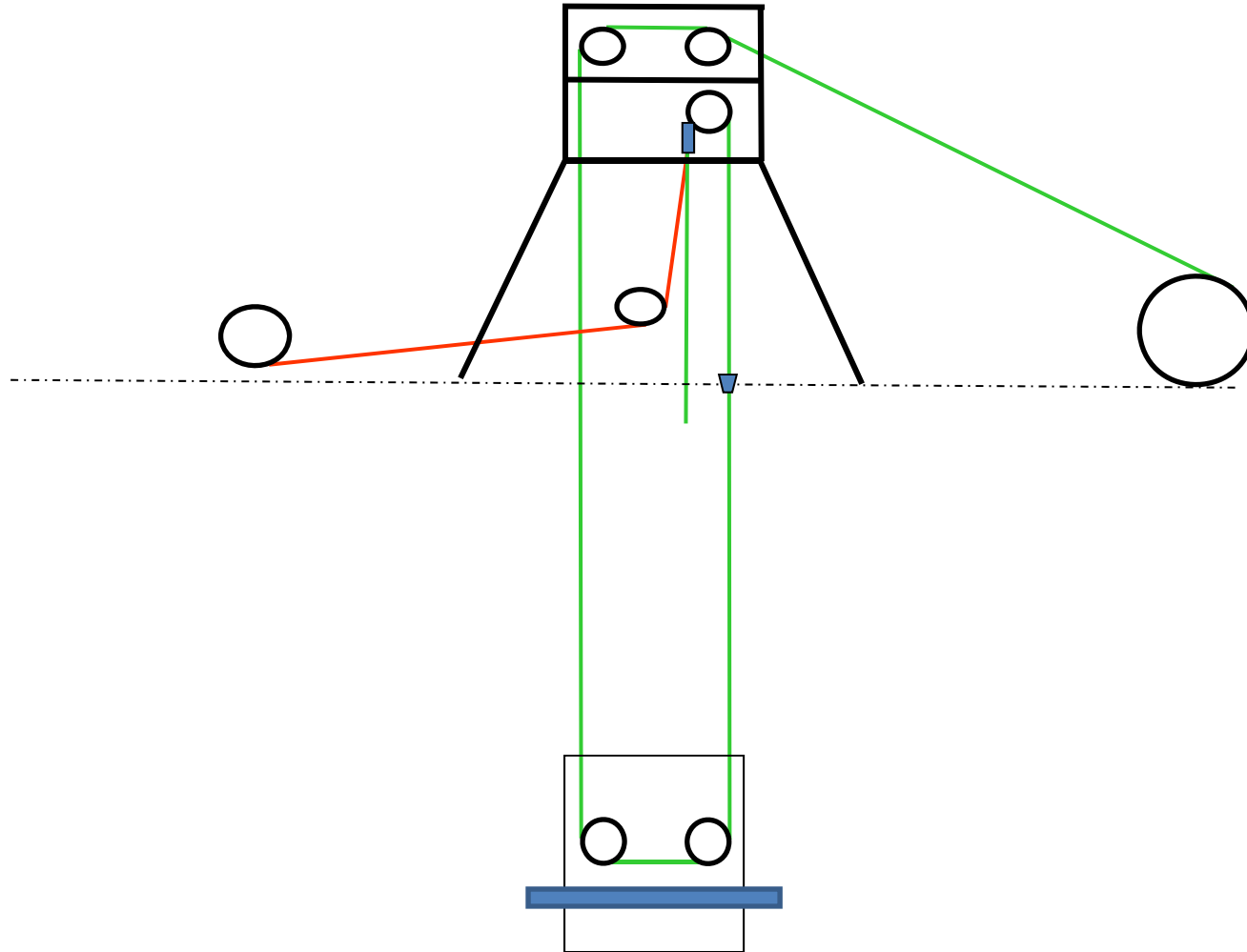
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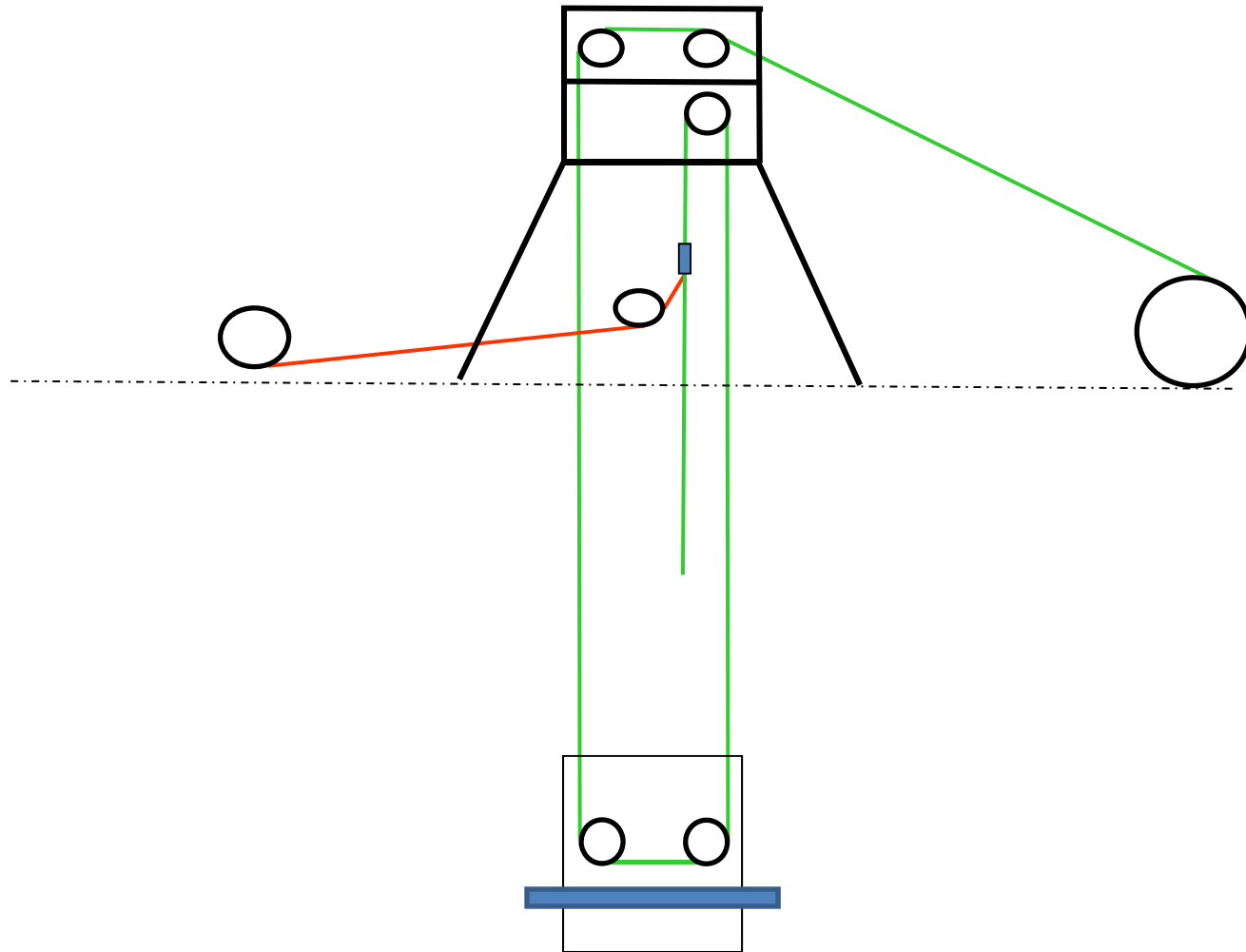
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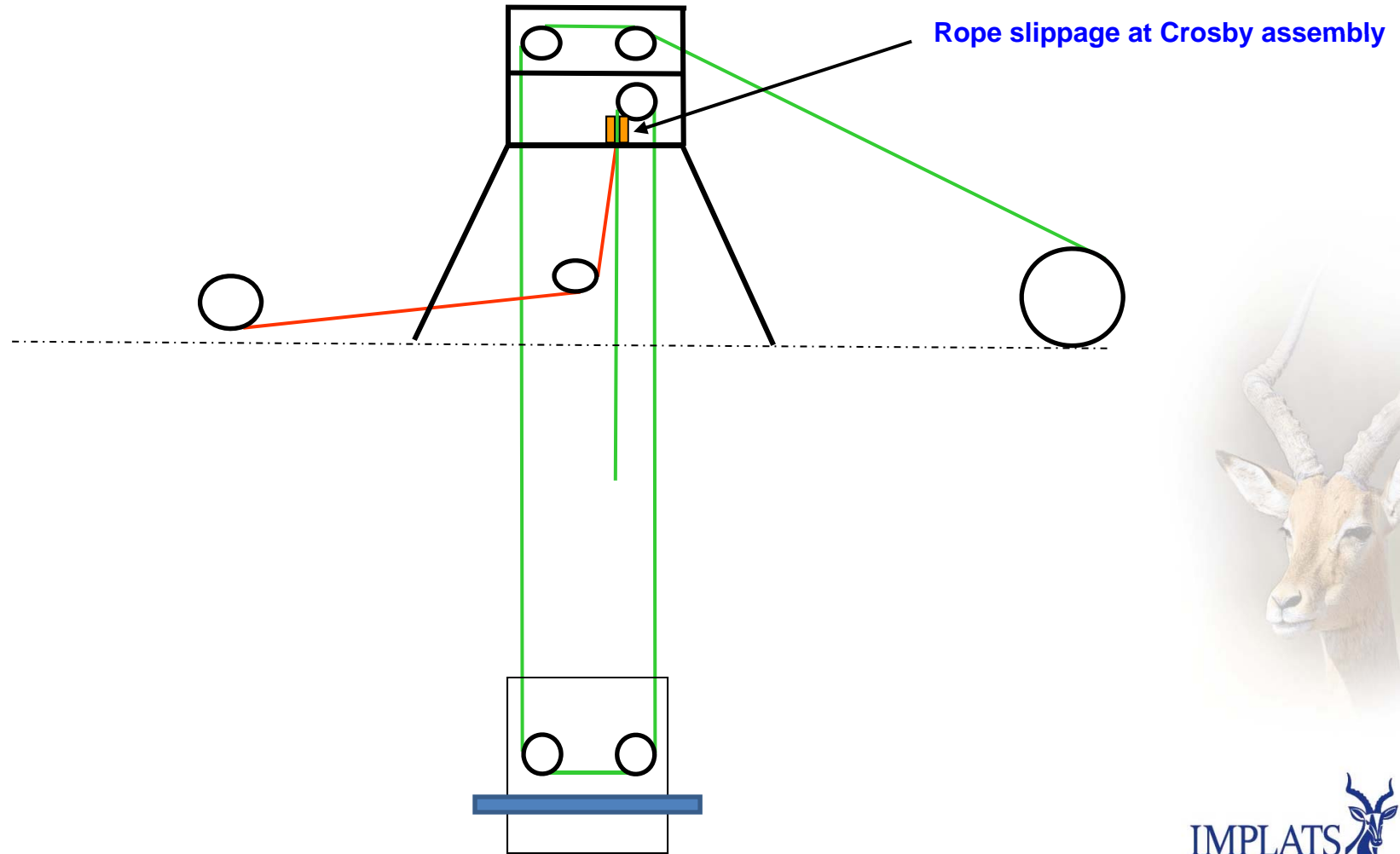
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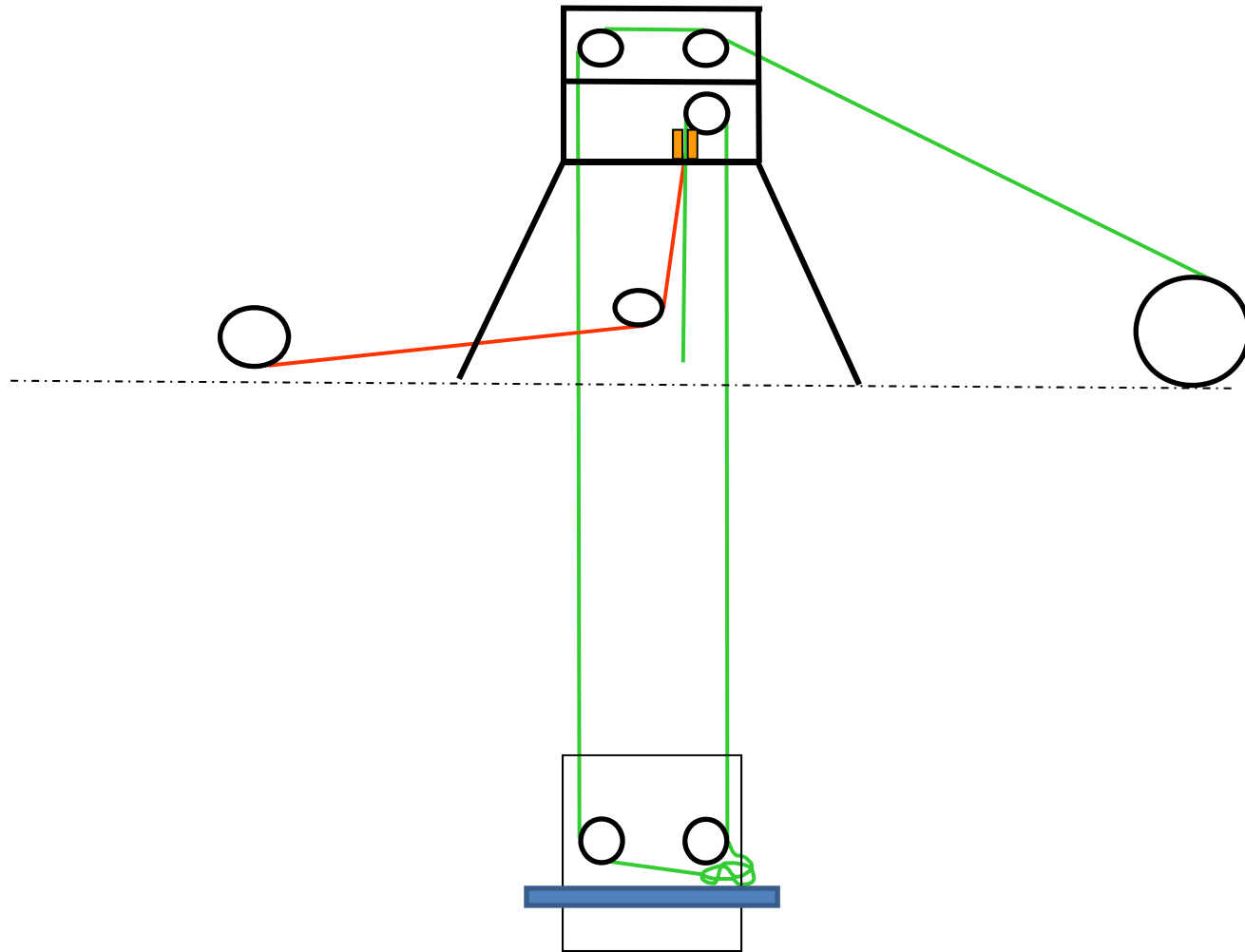
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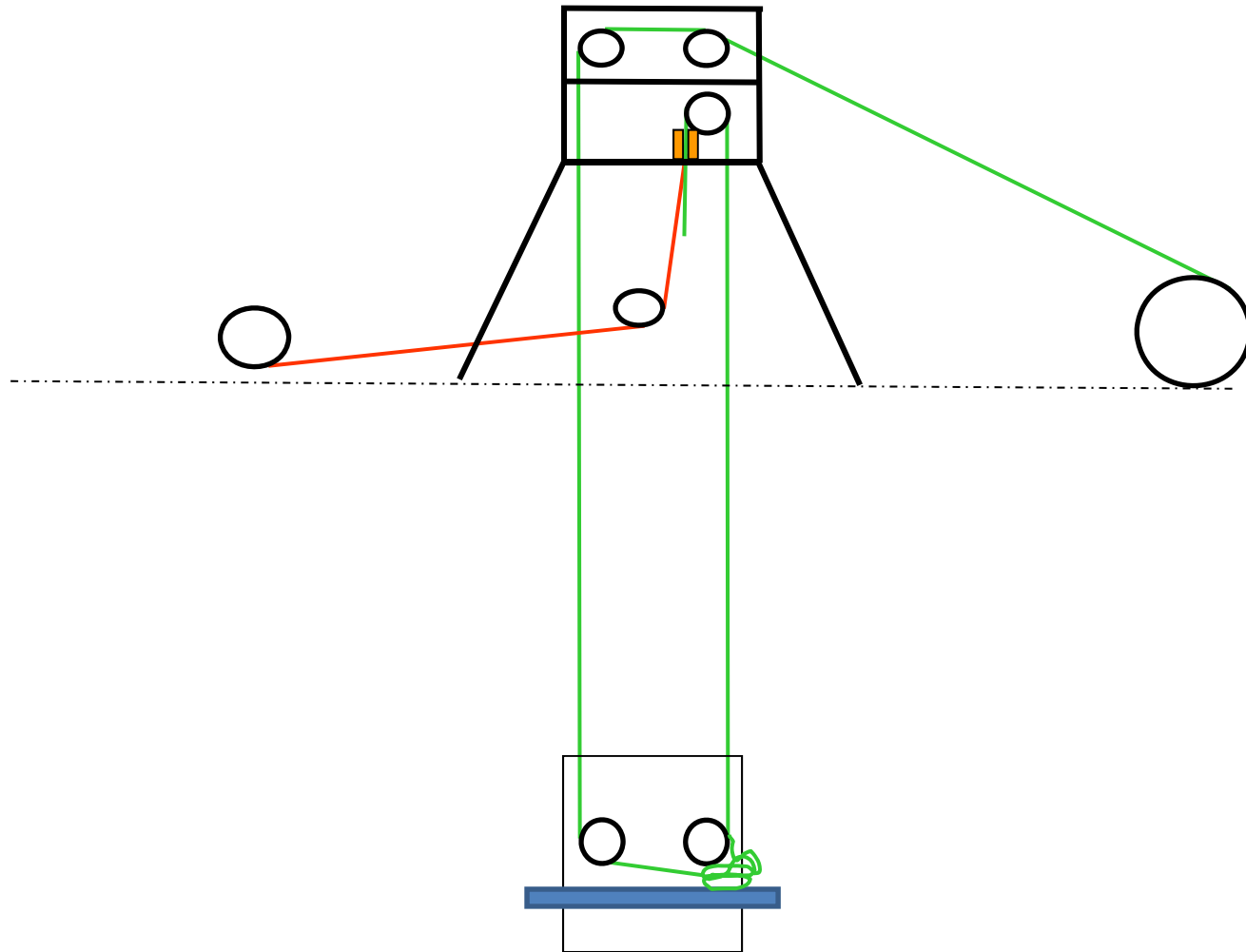
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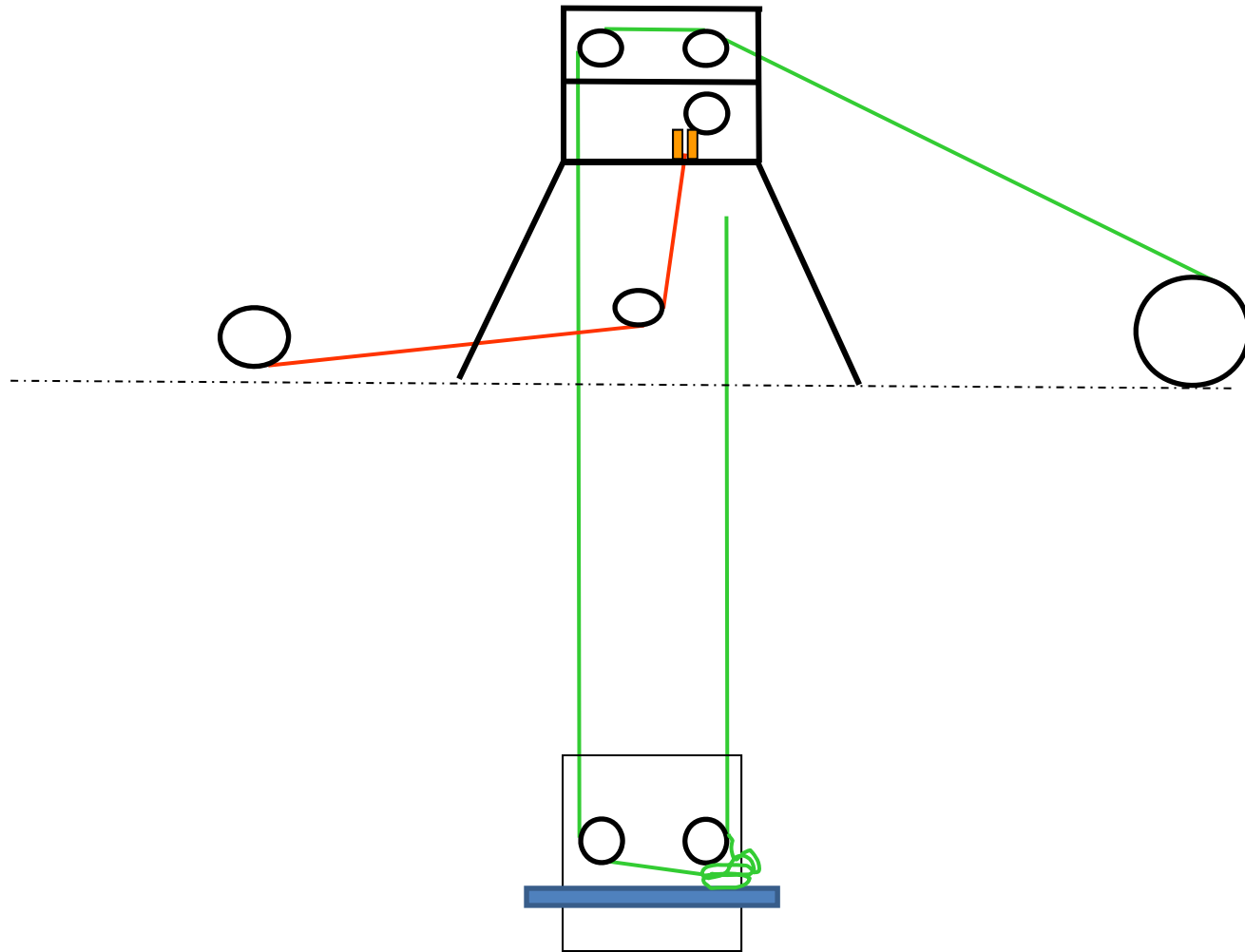
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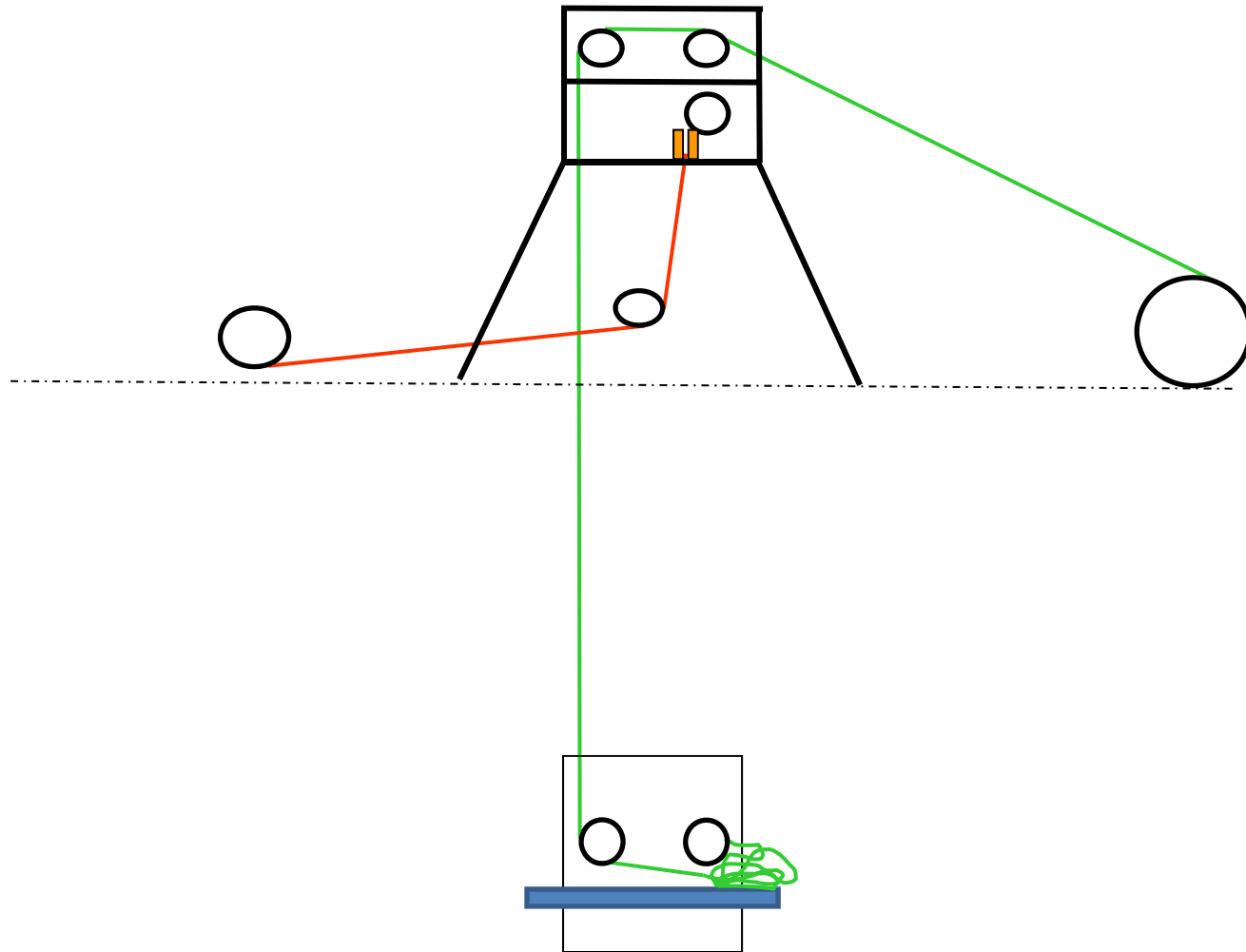
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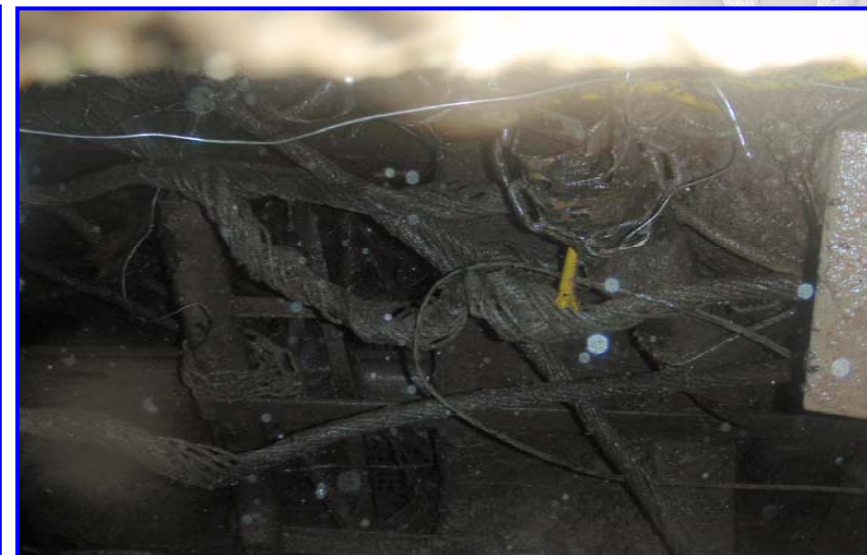
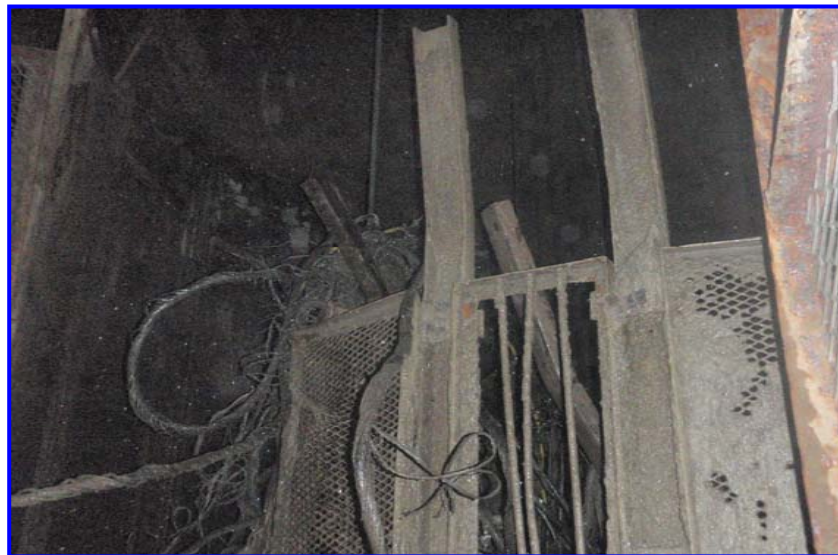
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NEW ROPE ON STAGE (1200m in length)



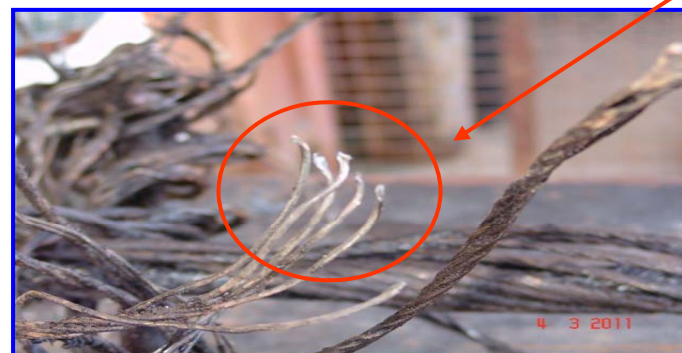
ANCHOR ROPE AFTER INCIDENT



Blue discoloration indicative of heat transfer



Localized material loss indicative of severe mechanical wear



ROPE SOCKET & CROSBY CLIP



INVESTIGATION FINDINGS

- Crosby assembly consisted of four clamps instead of eight as prescribed in the procedure.
- Crosby clamps were hand tightened with a spanner, previously done with a impact wrench.
- Total of six iterations were completed before the incident.
- Shift change: hand over from one fitter to another.
- Incident happened on the 2nd iteration after shift change.
- Fitter saw new rope starting to pull through within seconds after pulling of the new rope began.
- Both ropes moved down for a couple of centimetres before onset of total rope slippage.

POSSIBLE CAUSES

- Distortion of new rope caused reduction in diameter.
Eliminated: - Eye witness account.
- Report on destructive test carried out.
- Distortion of pull rope caused reduction in diameter.
Eliminated: - Eye witness account.
- Visual inspection of rope after incident.
- Winder and rope tensioner pulling against each other.
- Crosby clamp assembly not to standard.



CROSBY CLIP STANDARD

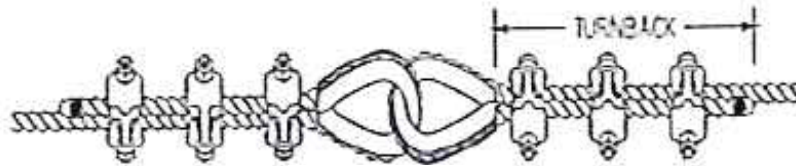


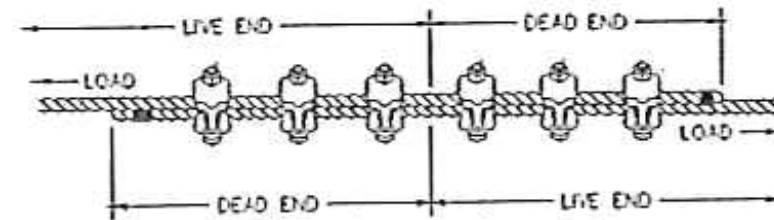
Table 1

Clips Size (in.)	Rope Size (mm)	Minimum No. of Clips	Amount of Rope to Turn Back in mm	* Torque in Nm
3/16	5	2	100	40.7
1/4	6-7	2	100	40.7
5/16	8	2	127	40.7
3/8	9-10	2	133	61.0
7/16	11-12	2	165	88.1
1/2	13	3	279	88.1
9/16	14-15	3	323	176
5/8	16	3	342	176
3/4	18-20	3	406	305
7/8	22	4	660	305
1	24-25	5	940	305
1-1/8	28-30	5	1040	488
1-1/4	32-34	6	1400	488
1-3/8	36	6	1570	678
1-1/2	38-40	7	1980	678

If a pulley (sheave) is used for turning back the wire rope, add one additional clip. See Figure 4.

If a greater number of clips are used than show in the table, the amount of turn-back should be increased proportionately.

* The tightening torque values shown are based upon the threads being clean, dry, and free of lubrication.



- Double the amount of turn back
- Double the amount of clamps

IMPORTANT:

- Check torque after load application

CROSBY STANDARD: SITE COMPLIANCE

REQUIREMENT	SPECIFICATION	SITE	COMPLIANCE
Turn Back	2,8m	3m	✓
Number of Clamps	12	4	X
Torque per Clamp	488 Nm	280 Nm	X

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What was the strength of the Crosby assembly at the time of the incident?

PULL TEST

RESULTS

Test piece: 2m turn back with four Crosby clamps

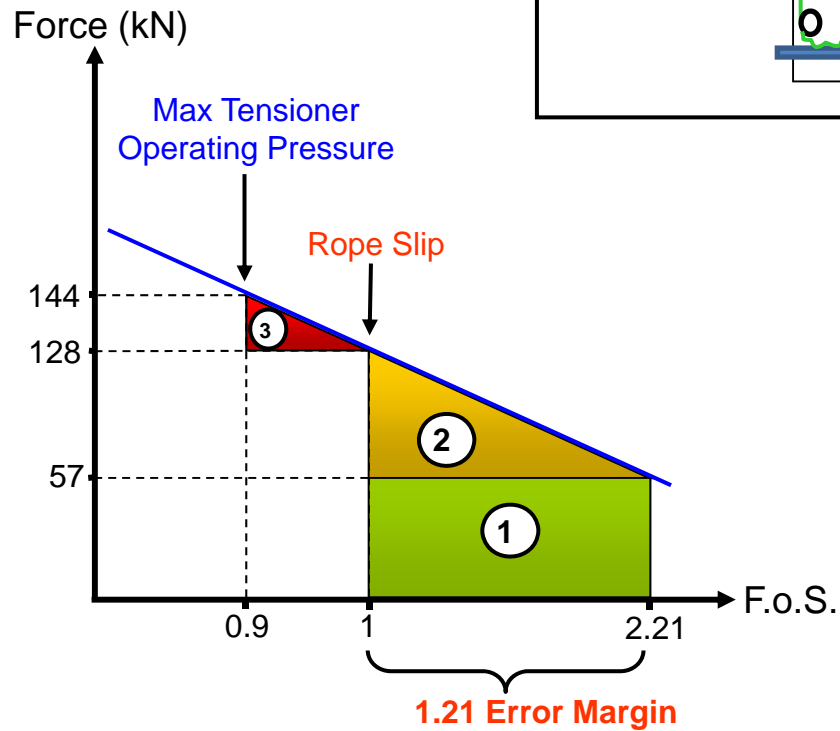
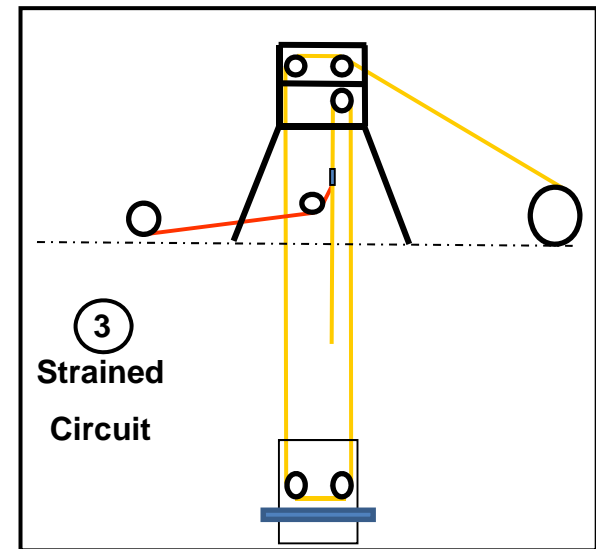
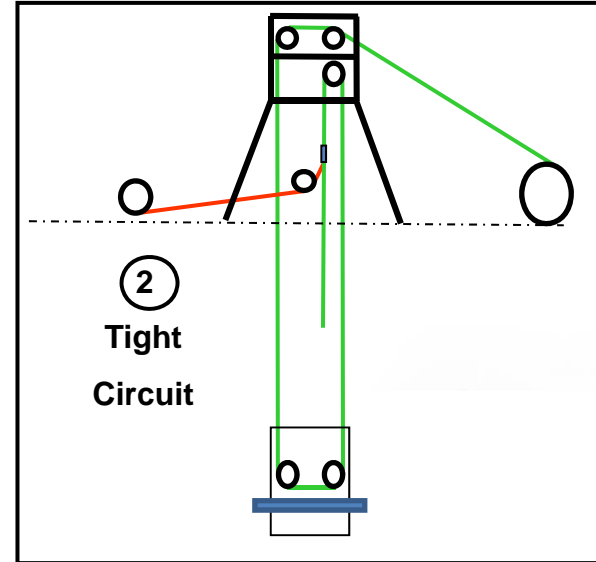
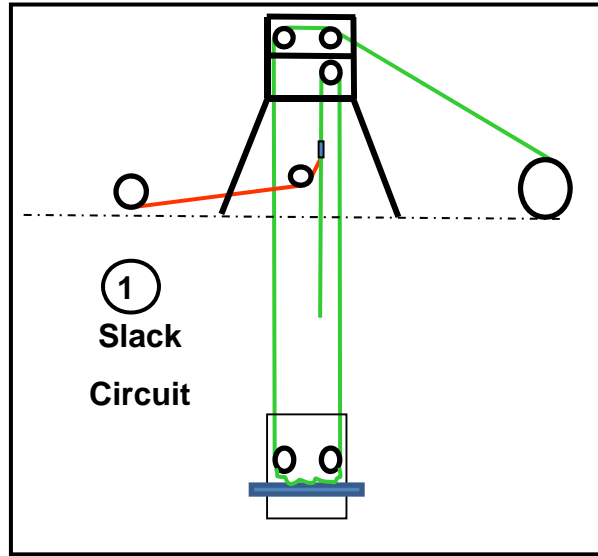
- Torqued specimen slipped at **278.5kN**
- Hand tightened specimen slipped at **128,5 kN**

TECHNICAL DATA: SITE

- **Anchor rope pull required:**
 - Slack continuously paid out by winder
57,68 kN
- **Maximum pull by tensioner:**
144,5kN (Stipulated in procedure, marked on rope tensioner pressure gauge)



ROPE SLIP SCENARIOS



CONCLUSION

- **Using four Crosby clips left no margin for error – F.o.S. of 1.21 is negligible**
 - **Fluctuation between the slack, tight and strained circuit was inherent to the rope-up method used.**
- **Incident might have been caused by:**
 - **Crosby clips not tightened properly.**
 - **Not enough slack was paid out, system changed from tight to strained from the onset.**
- **The eight clamps specified by the procedure would have been sufficient for slack, tight and strained system, even if they were only hand tightened.**

LESSONS LEARNT

- EMT interpretation – early warnings
 - Timeous action would have enabled a rope change at bank elevation eliminating the out of balance forces.
- Safe Work Procedures should include critical item check lists to be used to manage handovers.
- Risk Assessment should assign critical task over inspections to competent persons.



QUESTIONS?

